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ABSTRACT

The aim of the conference was to hold a working discussion on problems essential to the building of thesauri, a uniform comprehension of which would make it possible to build them in a manner ensuring easier communication and exchange of information between information systems covering different ranges of subject matter, and using different languages. The conference discussed the way essential terms such as "thesaurus," "descriptor," and "ascriptor" would be handled. The fundamental elements of which thesauri should consist were also discussed and special stress as laid on methods of thesauri building, selecting and qualifying descriptors, their structure, and interrelations and determination. The conference discussed the building of monolingual thesauri and some problems of polylingual thesauri and debated the Unesco publication, "Guidelines for the Establishment and Development of Monolingual Scientific and Technical Thesauri for Information Retrieval: third draft." (Author/AB)

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PROCEEDINGS

of the International Conference on General Principles of Thesauri Building

Warsaw, 23-27 March 1970

LI 002 920

Documentation and Scientific Information
Centre of the Polish Academy of Sciences
WARSAW 1970

PREFACE

THE INTERNATIONAL Conference on General Principles of Thesauri Building, organised in Warsaw from 23rd-27th March 1970 by the Documentation and Scientific Information Centre of the Polish Academy of Sciences, was attended by 33 participants from 13 countries. The aim of the conference was to hold a working discussion on problems essential to the building of thesauri, a uniform comprehension of which would make it possible to build them in a manner ensuring easier communication and exchange of information between information systems covering different ranges of subject matter, and using different languages.

This being so, the agenda provided only for a brief presentation by the participants of their particular views on issues which were in principle set out in the questionnaire, and most of the time was spent in discussing these matters. But other questions could be and were raised.

With a view to clarifying the ideas and meanings ascribed to particular terms, the conference discussed primarily the way these terms are to be understood. The terms included the essential ones such as "thesaurus", "descriptor" and "ascriptor" /"non-descriptor"/, and a great measure of unanimity was shown. The fundamental elements of which thesauri should consist were also discussed. Special stress was laid on methods of thesauri building, selecting and qualifying descriptors, their structure, interrelations and determination.

The conference discussed the building of monolingual thesauri and some problems of polylingual thesauri, debated the UNESCO publication "Guidelines for the Establishment and Development of Monolingual Scientific and Technical Thesauri for Information Retrieval: third draft", and tabled a number of amendments and remarks. Varying points of view were expressed on thesauri, their structure, methods of building and even their very essence. As the causes of the differences were exposed, there were chances to resolve them. Partial agreement on some basic formulations was also reached.

In publishing the preliminary material on the conference, its course and results, I would like to emphasise that these were only made possible by the dedication, effort and goodwill of the participants. I hereby thank them all. I would also like to express my deep gratitude to Professor Janusz Groszkowski, President of the Polish Academy of Sciences, for his active support and for his opening address. And I must also praise the important contribution to proceedings made by the conference secretary, Mrs. Barbara Krygier.

Kazimierz Leski

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23rd March; Afternoon Session - Jiři Toman
24th March; Morning Session - Loll N. Rolling
Afternoon Session · Joel J. Lloyd

25th March; Morning Session - Jacobus Gravesteijn
Afternoon Session - Thomas M. Aitchison

26th March; Afternoon Session - Henning Spang-Hanssen

27th March; Morning Session - David C. Weeks
Final Session - Kazimierz Leski

CONFERENCE ORDER

1. The role of thesauri
2. Terminological problems
   a. The definition of a thesaurus
   b. The definition of a descriptor
   c. The definition and name of forbidden terms
   d. What should be demanded in order to accept a term as a descriptor?
   e. The terminology of cross-references
3. Constructional problems
   a. Which elements should be included in a thesaurus?
   b. How should a descriptor be built?
4. Methodological problems
   a. Methods of building thesauri
      - for given thematic ranges
      - for overlapping fields /with other thematics/
      - of multilingual thesauri
   b. The methods of building descriptors
5. Conditions which descriptors and thesauri must fulfil in order to ensure their inter-branch and inter-language correlation
6. Conditions which must be fulfilled by descriptors and thesauri as tools for further development of information
7. Organisational problems
   a. How to organize the popularization of methods agreed, to give them the level of recommendations
   b. How to organize work in order to facilitate or make possible the building of correlated thesauri

OPENING ADDRESS

I take great pleasure in opening this conference, one of the first devoted to the building and development of thesauri.

I am also very pleased to greet the representatives of countries with varying attitudes to the problems of science and scientific information.

Despite all differences, the main tendency is towards co-operation, especially in the scientific field.

Scientific information is, of course, the basis of research. Without accurate information on the state of a given field of science, without sufficient knowledge of trends in other fields, without the recording of new achievements, scientific research cannot be practically efficient -- it cannot yield good results.

Developments which should be known to scientific workers and to economists take place in different countries, are worked out in differing languages and in different fields. The dissemination of such information precisely and quickly, and meeting all practical needs, is not a simple problem. Only systems which have similar means of determining the content of documents and an unambiguous method of inquiry can assure success.

And here I come to the main aim of today's conference. At the present stage of development of scientific information and technical methods at the disposal of the retrieval system, the most effective methodological tool to enable the precise assessment of information, documents and retrieval seems to be precisely the thesauri.

There is still a danger, however, that the thesauri elaborated in various countries and fields spontaneously, with only a small degree of co-ordinated activity, though streamlining the information system within the frameworks for which they are designed, may create additional linguistic, inter-branch and even inter-institutional barriers against a free flow of information.

The task before the members of this conference is to contribute to overcoming such barriers, or at least to reduce them to manageable proportions. This is a difficult and ambitious task. I believe, however, that considering even the practical difficulties which are yet to arise, a great deal can be done.

I also hope that the presence at this conference of representatives of UNESCO, UCSU and FID — organisations with great international authority — will contribute to overcoming those difficulties.

I am happy to have the opportunity to wish the debates every success — in terms of concrete results — and I also hope that even if the planned aim is not fully achieved, at least a worthwhile approach will have been made.

Now, since work is not the only thing in life, I also trust that you will spend your free time enjoyably, and may your memories of this visit bring you to Warsaw again in the future.

Once again wishing you fruitful discussions, I now give the floor to the organizers, and declare the conference open.

Prof. dr J. Groszkowski
President
of the Polish
Academy of Sciences

ANSWERS TO QUESTIONNAIRE ON THESAURUS PROBLEMS

Thomas M. Aitchison[x]

1. Definition of a thesaurus

A thesaurus is an alphabetical listing of concepts /i.e. descriptors / which provides structural and relational information about the concepts. A list of terms which does not include structural and relational information is not a thesaurus, even though it includes details of synonymous terms. It is merely an alphabetical list of subject headings or an alphabetical list of descriptors.

- Which structural elements /semantic, syntactic, etc./ should be included in order to be able to call a given construction a thesaurus?

A thesaurus should include the following: -

a/ Concepts /i.e. descriptors/arranged in alphabetical order

b/ Details about each concept, i.e.

/i/ Synonyms, alternative word forms, near synonyms, etc.

For example:-
AUTOMOBILES
UF Motor cars
with reciprocal entry
MOTOR CARS use
AUTOMOBILES
/UF represents "Use for"/

/ii/ Hierarchical /or structural/ relationships.

For example:-
AUTOMOBILES
BT Motor vehicles

---

[x] Institution of Electrical Engineers, London.

NT Estate cars

/BT represents "Broader term".
NT represents "Narrower term"/

/iii/ Relationships other than hierarchical. There are a wide variety of related terms, which may be roughly classified into groups, such as "thing/part", "thing/property", "process/agent", "thing/application" to name only a few.

For example:-

Thing/part
DIESEL ENGINE
RT Pistons
Thing/property
Pistons
RT Wear resistance
Property/process
WEAR RESISTANCE
RT Testing

/RT represents "Related term"/

- Which elements, factors, influence the organisation of the thesaurus?

a/ Subject field

/i/ General vs. specific subject fields. A thesaurus in a specific subject field will cover the subject field in greater detail than the general thesaurus. Some relationships between concepts are peculiar to a specific subject field. The same terms in a general thesaurus might not display the specific relationships.

/ii/ Differences between specific subject fields. Some subject areas have more precisely definable descriptors than others /i.e. "hard" versus "soft" language types/. In some subject areas synonyms abound, whilst in others they are not so common. In some subject fields the related terms and generic structure are more obvious than in others.

b/ Economic considerations

If costs must be kept low, this influences the specificity of the concepts selected and the number of related terms which are introduced.

- How should the degree of complexity and the number of information items, contained in a thesaurus be evaluated?

The more specific the concepts selected and the more highly "pre-coordinated" the descriptors, the more complex the thesaurus will become and the more terms it will include. A thesaurus in which the terms are at a "low level of pre-coordination" /with complex terms being constructed from these simple concepts at the indexing stage/ will have many fewer terms than those with "highly pre-coordinated" concepts. The disadvantages of low pre-coordination level concepts is that frequently-sought concepts are not included in the thesaurus and the description of the subject field is incomplete. If a concept is not listed, related concepts cannot be shown. There is need for research to find the optimum level of specificity /i.e. pre-coordination level/.

2. Is the concept of a thesaurus sufficiently complete and univocally and exhaustively defined, or does it necessitate further analysis?

Further analysis is required on the following points:-

a/ Rules for the selection of related terms /RT/. At present the choice of related terms seems to be made haphazardly. Where thesauri are constructed on a classified basis some help is given in this problem, but there are relationships which cut across hierarchical groups which can only be identified by those with a good knowledge of the subject field. It may be that it is impossible to draw up detailed rules for selection of related terms.

b/ Selection of specificity and pre-coordination level of concepts. /see above/

c/ Thesaurus /classification systems. Advantages/disadvantages of combining thesauri with classification systems. Problems in construction and use.

Advantages.

/i/ Thesaurus and classification in a combined system complement each other. The classification provides a visual display of subject fields showing hierarchical and other relations whilst the thesaurus acts as an index to the classification and at the same time ensures control or synonyms and indicates related terms which cut across the hierarchies in the classified schedules.

/ii/ A thesaurus/classification system is a multipurpose tool which can be used for the arrangement of books on shelves /because it includes notation/ and for conventional classified catalogues. Using the descriptors it may be used for post-coordinate systems and for computer searching.

3. What is the role of a thesaurus?

- direct use in information and retrieval systems

a/ For controlled retrieval languages. Provides list of controlled descriptors for indexing and searching. It also provides generic and relational information which allows for generic posting at the indexing stage, and manipulation of the question at the searching stage /i.e. the search may be made broader or more specific by use of hierarchical relationships shown in the thesaurus - and more exhaustive by drawing upon related terms/.

b/ Natural language systems. Thesauri can be used to suggest alternative terms etc. in compiling search formulations in natural language. A different type of thesaurus may be required for free-text searching; but no research has been done as yet on this problem.

in development of scientific information.

The listing of scientific terms showing structural and relational information reveals interdisciplinary relationships. Unfortunately thesauri are always lagging behind scientific developments.

4. Methods of construction of thesauri

- Methods of compiling thesauri

  There are obviously many: this is a personal view.

  a/ Definition of subject field.

  b/ Classification of subject field into main groups or facets.

  c/ Collection of concepts /descriptors/ in each subject group or facet. Terms obtained from the literature, from other thesauri and classification systems, dictionaries etc. - also from subject experts.

  d/ Tabulate data on each concept. Find synonyms, etc.

  e/ Arrange concepts in detailed classification within each main subject group: this will assist in distinguishing hierarchical and other relationships.

  f/ Arrange terms alphabetically. Insert use entries and check that BT/NT and RT entries are reciprocal.

- Possibilities and advantages of automation in compilation of thesauri

  The advantage of automatic compilation is that it ensures full reciprocity and avoids errors. It also takes much of the manual drudgery out of thesaurus compilation. Automation should also facilitate up-dating and allow frequent new editions.

5. Conditions which descriptors and thesauri must fulfill in order to ensure their inter-branch and inter-language correlation

Inter-branch correlation can best be achieved if the thesaurus is compiled with the assistance of a classification system. This will reveal that many concepts have applications in more than one subject area and may fit into several hierarchies.

6. Conditions which must be fulfilled by descriptors and thesauri as tools for further development of information

a/ Thesauri must be easily up-dated. They must be hospitable to new material. Technology is changing so quickly that thesauri can never keep up. There should be frequent new editions. This should be less expensive with automated compilation.

b/ The change to natural language retrieval systems /which is likely to come about with increased mechanisation/ may demand a new type of thesaurus. More synonym dictionaries may be required, and at the same time a larger number of specialised thesauri - which must be rapidly up-dated.

SOME OBSERVATIONS ON THESAURUS PROBLEMS

Rolf Jansen[x]

1. Definitions

Concept: Mental idea of material or immaterial object based on common characteristics which are usually formed by abstraction and found identical.

Term: Name given to a concept and consisting of one or more words.

Descriptor: Univocal representative of a concept in a documentation system. The descriptor can be a fixed term /"preferred term"/ or any other designation.

Thesaurus: For purposes of information storage and retrieval a thesaurus is an orderly compilation of concepts

- represented by as many synonymous terms as possible in one or more languages,
- in which homonymous terms are specially marked,
- in which a descriptor univocally represents a concept, and
- in which semantic relationships between concepts are registered.

Relationships can be derived from the definitions of the concepts.

2. Structural elements of a thesaurus

Before determining the organisation of a thesaurus and its structural elements, it will be useful to consider the principal role of a thesaurus in documentation. The main object of a thesaurus is to facilitate information retrieval. Therefore the following truism holds:

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[x] Badische Anilin- & Soda-Fabrik AG, AL/Dokumentation, C 6 67 Ludwigshafen/Rhein.

A documentation search asks for concepts rather than words. The questioner has an idea of the facts wanted, but the way in which the facts are expressed in a document or file does not usually matter much. Any arbitrary formulations in the document or inquiry must therefore be eliminated, i.e. reduced to the level of the concept.

Concepts as elements of information retrieval are therefore the basic elements of a thesaurus. Because concepts are expressed by words and a number of synonymous terms may stand for a single concept, the conceptual level must be specially identified. Other measures that enable terms to be clearly assigned to concepts include:

o Homonymous terms should be identified. Short additions indicating the different meanings will do away with homonymity and establish clear assignments.

o For retrieval purposes it is convenient to use a designation that univocally represents a concept and is called a "descriptor". It is of minor importance whether this descriptor is a preferred term, a concept number or a systematic notation, although of course a notation is convenient in that it indicates not only the identity of a concept, but also its hierarchic relationships with other concepts.

The basic information contained in a thesaurus includes not only means of identifying conceptual levels, synonyms and homonyms, their assignment to concepts, and the designations of descriptors, but also the semantic relationships between concepts, especially the hierarchical relationships. They form the essential framework in any organization of concepts and play a decisive part in information retrieval. Every question is bound to incorporate hierarchical elements, either because narrower concepts have to be taken into account or because the inquiry is relatively broad, i.e. starts at a higher level to avoid losses.

As regards the construction of the hierarchy it should be noted that conceptual reality is polyhierarchic in nature and manifests itself in netlike connections. Polyhierarchy means that a concept can be assigned not only narrower concepts but also any number of broader concepts.

Other useful information in a thesaurus includes foreign-language equivalents, different spellings, definitions of concepts or explanations, important sources of conceptual information and aspects of subordination of concepts.

An example of a thesaurus structure is described below. It has been prepared at BASF and adopted by IDC Internationale Dokumentations-gesellschaft für Chemie[2]. For each concept all pertinent information is registered together in a specific sequence. To enable the information to be processed by computer, every item starts with a symbol identifying the various entries. The total amount of information for each concept is called a "concept set". The various entries in the concept sets of the IDC Thesaurus are listed in Table 1.

The concept entries were made as versatile as possible to enable all details available to be readily incorporated without loss of information and to provide for any future extension to new fields of activity. The first entries are intended for the registration of synonymous terms in different languages. At the end of each concept set are the directly related concepts, always represented by one of the synonymous terms. Polyhierarchical relationships exist where a concept is assigned more than one broader concept.

The middle of any concept set is reserved for additional information, such as definitions and sources. Under entry "K" each concept is assigned to one or more concept fields which are based on aspects of concept categories and enable concepts to be preordered by subject groups as the thesaurus grows. Assignment to concept fields is by means of predetermined symbols consisting of two capital letters /e.g. EO = properties, optical/.The IDC Thesaurus covers about 40 concept fields which are important in chemical documentation. Figure 1 shows some concept sets taken from the concept area "Optical Properties".

	Begriffsbenennungen	Concept Terms
B	Benennungen in Deutsch: Synonyme und Quasi-Synonyme	Terms in German: Synonyms and near-synonyms
C	Benennungen in Deutsch: Unterschiedliche Wortformen und Schreibweisen	Terms in German: Different Forms of the Same Word and Different Spellings
E	Benennungen in Englisch	Terms in English
F	Französisch	French
I	Italienisch	Italian
J	Spanisch	Spanish
N	Niederländisch	Dutch
P	Portugiesisch	Portuguese
	Zusätzliche Information	Additional Information
D	Begriffsdefinition	Definition, "Scope Note"
H	Hinweise zur Benutzung	Instructions for Usage
K	Begriffsgebiets-Einteilung /2-stellige Symbole/	Concept Field /Two-digit Symbols/
Q	Quellen-Kurzangaben	Coded References
	Beziehungsbegriffe	Relation Concepts
	Übergeordnete Begriffe:	Generic Concepts:
O	Oberbegriff	Broader Concept
S	Verbandsbegriff	Total Concept
X	Bezugsbegriff	Reference Concept
	Untergeordnete Begriffe:	Specific Concepts:
U	Unterbegriff	Narrower Concept
T	Teilbegriff	Part Concept
Z	Zugehörigkeitsbegriff	Accompanying Concept
G	Gegenbegriff	Opposite Concept
V	Verwandter Begriff	Related Concept
	/Begriffssatzende	Concept Set Ending/

Tab. 1 Angabenkategorien der Begriffssätze des IDC-Thesaurus
Table 1 Entries of "Concept Sets" in IDC Thesaurus

3. Computer methods in thesaurus compilation

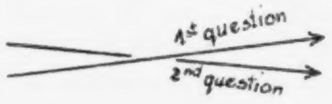
Computer methods of processing thesaurus information will be described below with reference to the IDC thesaurus.

The concept sets are punched on cards and fed to the computer, which assigns a serial number /"concept number"/ to each concept set and carries out various checking operations such as whether

/1/ any terms fed in are already available in the thesaurus, or

/2/ any terms specified as relation concepts have themselves been defined as concepts, i.e. occur under the categories for synonymous terms in another concept set. If not, the programme adds the missing concept together with the appropriate reference and a concept number. Otherwise the computer checks to see whether the reciprocal relationship is available and adds it, if necessary /"mutual completion of concept sets"/.

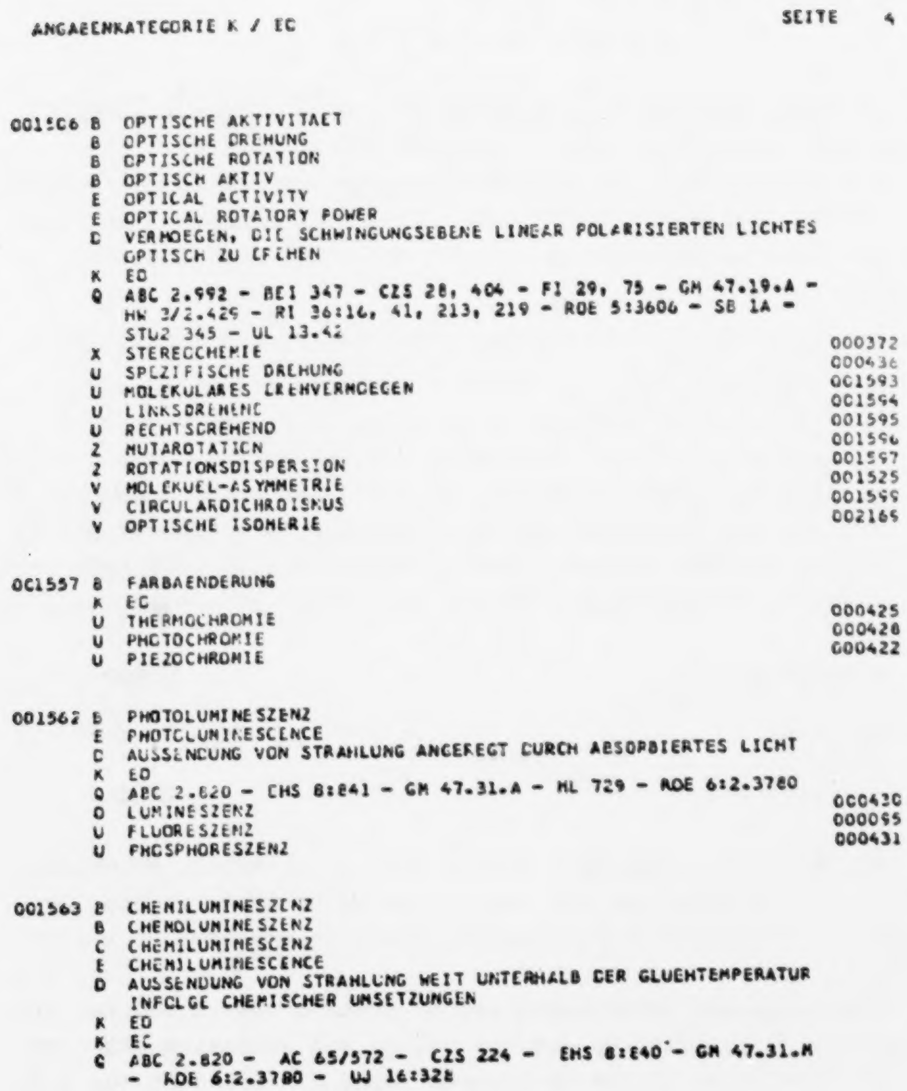
Concept fed in	Check
E fuel	E fuel oil
U fuel oil	O fuel



The checking programmes ensure that all semantic relationships are completed and all terms, including those in the categories of concept relationships, occur as synonyms of a concept.

The completed information can be printed out in ordered arrangement, classified by concept groups and completed with an alphabetical list of the synonymous terms specified in the subject section. Fig. 1 is a specimen of this section, while Fig.2 illustrates the alphabetical register. The computer printouts save the trouble of setting up and maintaining a card index which in the initial phase would have to be continuously improved and completed.

A disadvantage of thesaurus organization is that the relationships given for each concept always indicate only one hierarchical level. Therefore a computer programme has been deve-



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ANGAEENKATEGORIE K / EC                                         SEITE    4


001506 B  OPTISCHE AKTIVITAET
       B  OPTISCHE DREHUNG
       B  OPTISCHE ROTATION
       B  OPTISCH AKTIV
       E  OPTICAL ACTIVITY
       E  OPTICAL ROTATORY POWER
       D  VERMOEGEN, DIE SCHWINGUNGSEBENE LINEAR POLARISIERTEN LICHTES
          OPTISCH ZU DREHEN
       K  ED
       Q  ABC 2.992 - BEI 347 - CZS 28, 404 - FI 29, 75 - GM 47.19.A -
          HW 3/2.429 - RI 36:16, 41, 213, 219 - ROE 5:3606 - SB 1A -
          STU2 345 - UL 13.42
       X  STEREOCHEMIE                                                  000372
       U  SPEZIFISCHE DREHUNG                                           000436
       U  MOLEKULARES DREHVERMOEGEN                                     001593
       U  LINKSDREHEND                                                  001594
       U  RECHTSDREHEND                                                 001595
       Z  MUTAROTATION                                                  001596
       Z  ROTATIONSDISPERSION                                           001597
       V  MOLEKUEL-ASYMMETRIE                                           001525
       V  CIRCULARDICHROISMUS                                           001599
       V  OPTISCHE ISOMERIE                                             002165


001557 B  FARBAENDERUNG
       K  EC
       U  THERMOCHROMIE                                                 000425
       U  PHOTOCHROMIE                                                  000428
       U  PIEZOCHROMIE                                                  000422


001562 B  PHOTOLUMINESZENZ
       E  PHOTOLUMINESCENCE
       D  AUSSENDUNG VON STRAHLUNG ANGEREGT DURCH ABSORBIERTES LICHT
       K  ED
       Q  ABC 2.820 - EHS 8:841 - GM 47.31.A - HL 729 - ROE 6:2.3780
       O  LUMINESZENZ                                                   000430
       U  FLUORESZENZ                                                   000095
       U  PHOSPHORESZENZ                                                000431


001563 B  CHEMILUMINESZENZ
       B  CHEMOLUMINESZENZ
       C  CHEMILUMINESCENZ
       E  CHEMILUMINESCENCE
       D  AUSSENDUNG VON STRAHLUNG WEIT UNTERHALB DER GLUEHTEMPERATUR
          INFOLGE CHEMISCHER UMSETZUNGEN
       K  ED
       K  EC
       Q  ABC 2.820 -  AC 65/572 -  CZS 224 -  EHS 8:840 - GM 47.31.M
          -  ROE 6:2.3780 -  UJ 16:328
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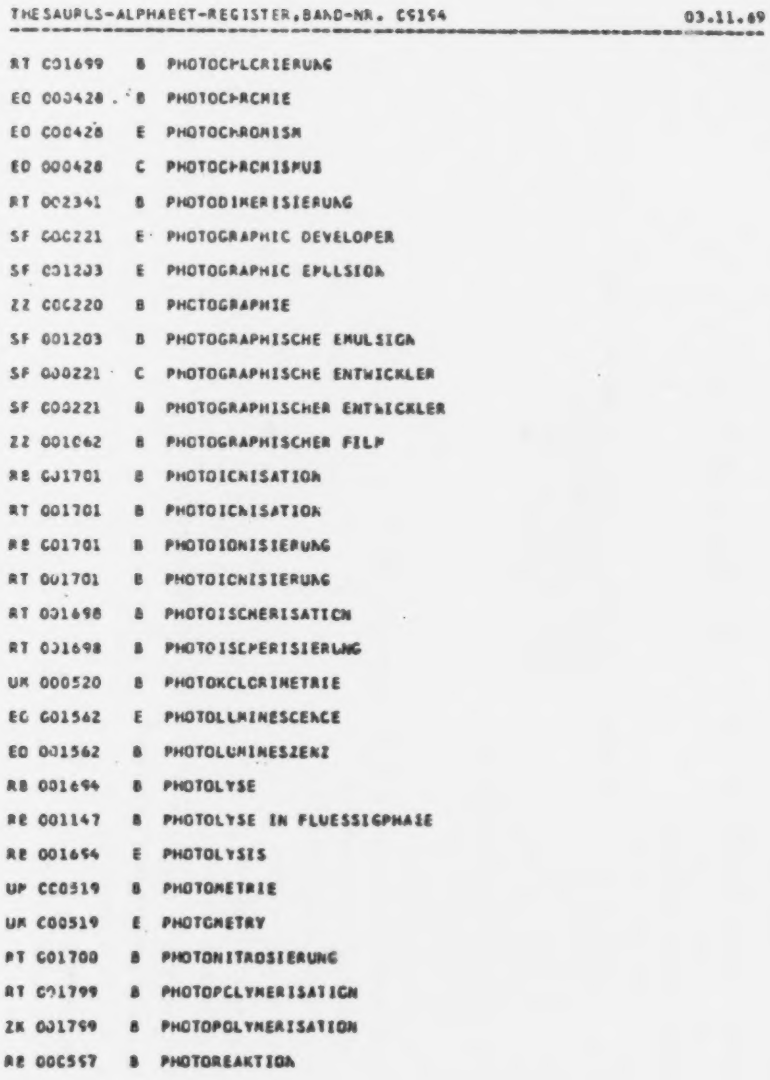
Fig. 1 IDC Thesaurus, arrangement by concept fields, within fields by ascending concept numbers



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THESAURUS-ALPHABET-REGISTER,BAND-NR. 09194                          03.11.69
--------------------------------------------------------------------------------
RT 001699   B  PHOTOCHLORIERUNG
EO 000428   B  PHOTOCHROMIE
EO 000428   E  PHOTOCHROMISM
EO 000428   C  PHOTOCHROMISMUS
RT 002341   B  PHOTODIMERISIERUNG
SF 000221   E  PHOTOGRAPHIC DEVELOPER
SF 001203   E  PHOTOGRAPHIC EMULSION
ZZ 000220   B  PHOTOGRAPHIE
SF 001203   B  PHOTOGRAPHISCHE EMULSION
SF 000221   C  PHOTOGRAPHISCHE ENTWICKLER
SF 000221   B  PHOTOGRAPHISCHER ENTWICKLER
ZZ 001062   B  PHOTOGRAPHISCHER FILM
RE 001701   B  PHOTOIONISATION
RT 001701   B  PHOTOIONISATION
RE 001701   B  PHOTOIONISIERUNG
RT 001701   B  PHOTOIONISIERUNG
RT 001698   B  PHOTOISOMERISATION
RT 001698   B  PHOTOISOMERISIERUNG
UK 000520   B  PHOTOKOLORIMETRIE
EO 001562   E  PHOTOLUMINESCENCE
EO 001562   B  PHOTOLUMINESZENZ
RB 001694   B  PHOTOLYSE
RE 001147   B  PHOTOLYSE IN FLUESSIGPHASE
RE 001694   E  PHOTOLYSIS
UP 000519   B  PHOTOMETRIE
UK 000519   E  PHOTOMETRY
RT 001700   B  PHOTONITROSIERUNG
RT 001799   B  PHOTOPOLYMERISATION
ZK 001799   B  PHOTOPOLYMERISATION
RE 000557   B  PHOTOREAKTION
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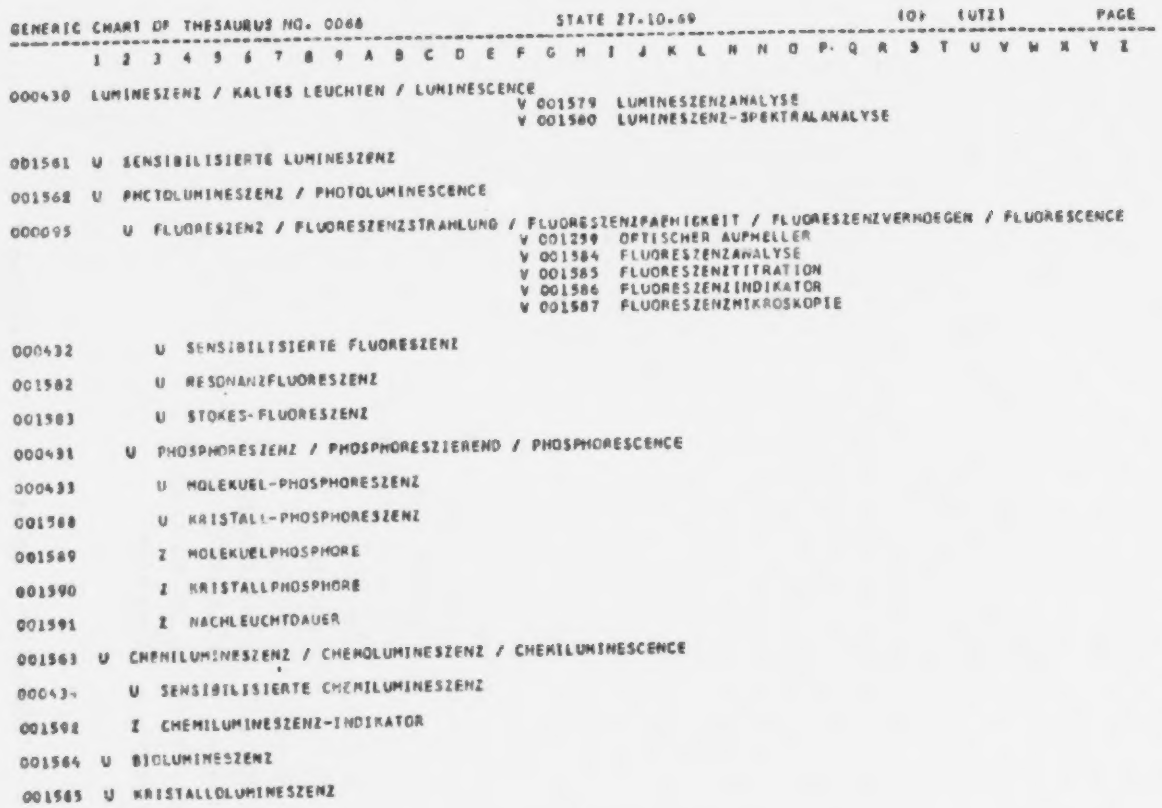
Fig. 2 Alphabetical index of I C Thesaurus



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GENERIC CHART OF THESAURUS NO. 0066                  STATE 27.10.69                     (O)   (UTZ)          PAGE
------------------------------------------------------------------------------------------------------------------
        1  2  3  4  5  6  7  8  9  A  B  C  D  E  F  G  H  I  J  K  L  M  N  O  P. Q  R  S  T  U  V  W  X  Y  Z

000430  LUMINESZENZ / KALTES LEUCHTEN / LUMINESCENCE
                                                    V 001579  LUMINESZENZANALYSE
                                                    V 001580  LUMINESZENZ-SPEKTRALANALYSE

001561  U  SENSIBILISIERTE LUMINESZENZ

001562  U  PHOTOLUMINESZENZ / PHOTOLUMINESCENCE

000095     U  FLUORESZENZ / FLUORESZENZSTRAHLUNG / FLUORESZENZFAEHIGKEIT / FLUORESZENZVERMOEGEN / FLUORESCENCE
                                                    V 001259  OPTISCHER AUFHELLER
                                                    V 001584  FLUORESZENZANALYSE
                                                    V 001585  FLUORESZENZTITRATION
                                                    V 001586  FLUORESZENZINDIKATOR
                                                    V 001587  FLUORESZENZMIKROSKOPIE

000432        U  SENSIBILISIERTE FLUORESZENZ

001582        U  RESONANZFLUORESZENZ

001583        U  STOKES-FLUORESZENZ

000431     U  PHOSPHORESZENZ / PHOSPHORESZIEREND / PHOSPHORESCENCE

000433        U  MOLEKUEL-PHOSPHORESZENZ

001588        U  KRISTALL-PHOSPHORESZENZ

001589        Z  MOLEKUELPHOSPHORE

001590        Z  KRISTALLPHOSPHORE

001591        Z  NACHLEUCHTDAUER

001563  U  CHEMILUMINESZENZ / CHEMOLUMINESZENZ / CHEMILUMINESCENCE

00043-     U  SENSIBILISIERTE CHEMILUMINESZENZ

001592     Z  CHEMILUMINESZENZ-INDIKATOR

001564  U  BIOLUMINESZENZ

001565  U  KRISTALLOLUMINESZENZ
```

Fig. 3 IDC Thesaurus, hierarchical arrangement of concepts

loped at BASF which on the basis of the relationship entries enables the thesaurus concepts to be printed out in the usual hierarchical arrangement. The individual concepts, represented by concept numbers and synonymous terms, are listed systematically in seperate lines, hierarchical levels being indicated by indentation. Capital letters preceding the terms indicate the different types of subordination /cf. Fig. 3/.

4. Use of a thesaurus in a computerized documentation system

There is yet another aspect to the computer processing of the IDC Thesaurus. The thesaurus is an integral part of a computerized documentation system[2,3] for the storage and retrieval of conceptual information. The alphabetically-sorted thesaurus tape is used for computer classification of terms that have been fed in.

A brief outline of the procedure is given below. The conceptual information which represents the contents of a document is written as clear text on coding sheets /"indexing"/.The wording of the concepts is free within certain limits governed by rules. The newly-fed terms are alphabetically sorted and then matched against the alphabetic thesaurus tape. All new terms are printed out and pass to the thesaurus specialist for checking, editing and incorporation into the thesaurus. This is followed by computer checking, up-dating and arranging operations. By comparison with the up-dated alphabetic thesaurus tape all terms on the file tape can be replaced by concept numbers and later by hierarchical notations and thus standardized.

The procedure is illustrated in Fig. 4 in a simplified flow chart which shows two cycle processes, the storage and thesaurus cycles which meet where the two tapes are correlated. It will be seen that the IDC Thesaurus is an open concept system which is kept constantly up-to-date owing to the automatic feedback.All improvements in and additions to the hierarchical structure can be subsequently transferred to the entire file. In this way,not only is the information kept up-to-date, but also the system can be adapted to future requirements.

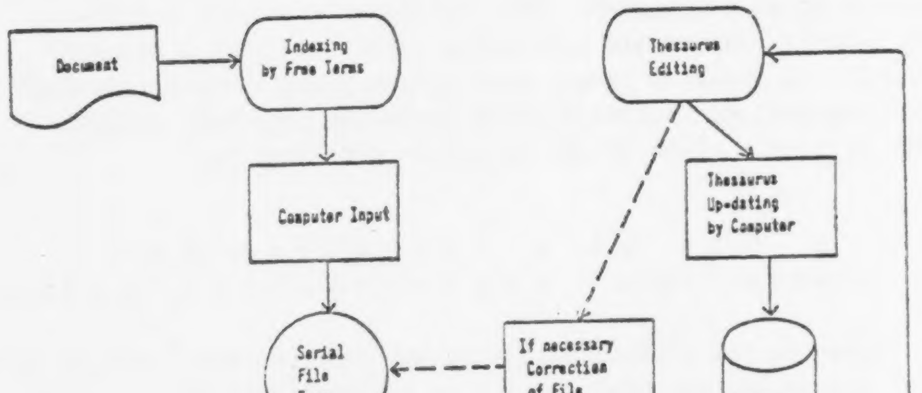
Document
Indexing by Free Terms
Thesaurus Editing
Computer Input
Thesaurus Up-dating by Computer
Serial File Tape
If necessary Correction of File
Thesaurus
Replacement of Free Terms by Concept Numbers
Alphabetic Sort of Terms
Alphabetic Sort of Terms
Systematic Arranging
Alphabetic File Tape
Alphabetic Thesaurus Tape
Thesaurus Printouts
File Terms with Concept Numbers
yes
Term already in Thesaurus?
no
List of not yet Contained Terms
Serial File Tape with Concept Numbers
Search
Query Formulation

Figure 4. IDC Documentation of Concepts
Simplified Flow Chart

The fact that there is no fixed vocabulary is also an advantage. To cut out errors in formulating the contents of documents, particularly apt terms can be used and new concepts can be fed in without any delay. The thesaurus being multilingual, indexing is independent of language. Classification and coding of concepts have to be done only once, and then they take place automatically with always the same results.

5. General premises and problems of thesauri building

5.1 "Pre-coordinated" concepts or splitting into "post-coordinated" concepts

One of the more serious problems is the recognition and handling of compound or "pre-coordinated" concepts. By compound concept is meant a concept which can be mentally split up into separate concepts, the mental addition of which is certain to lead back to the initial concept. Accordingly, a single independent and unambigous concept is to be looked upon as the smallest conceptual unit whose further mental separation is pointless.

The problem apparently is that it is not possible to find an absolute standard for defining a demarcation between single concepts and compound concepts, the definition of demarcation depending on the user's point of view. In documentation the definition depends upon the requirements of information retrieval.

In a system of concepts the ratio between hierarchy and coordination is determined by the degree of subdivision of concepts. Concepts which are dissected do not exist in the thesaurus as such. Synonyms, definitions and hierarchical relationships cannot be registered. Dissection of concepts interferes with the hierarchy of the classification system.

Because dissection influences indexing and thesaurus building, it is necessary to establish certain rules taking into account the significance of hierarchy for the ordering of concepts and for information retrieval. On the other hand it is important to consider whether compound concepts, if any, should be entered into both file and thesaurus if the combination of their basic concepts /"post-coordinated" concepts/ can be stored just as unambiguously and appropriately. In any case a clear distinction should be made between the mental dissection of concepts and the purely linguistic dissection of compound terms or words.

Under the indexing rules of IDC the basic policy is to dissect concepts only to the extent that the original conceptual connection in the context is not lost and there is no change in meaning. Each of the single concepts, when considered out of context, should have professional information value and be definite in scope.

5.2 Treatment of synonyms and homonyms

The question of conceptual unity also appears in connection with synonymity, i.e. when it is to be decided whether terms should be registered as synonyms or quasi-synonyms for a particular concept or whether they designate different concepts. In linguistics the opinion is held that there are no true synonyms and that each term stands for a new and independent concept. In documentation, where the emphasis is on practical usefulness, such rules are too strict. In checking terms for synonymity the question is not only whether differences in the definitions of the concepts can be detected, but also whether usage differs in the literature and whether any difference is relevant for information retrieval purposes.

While synonyms are independent of context by definition, homonyms depend on the context and should therefore be identified as such during indexing. In the thesaurus the best way to characterise homonyms is to write a parenthetic expression behind the term; this expression should contain a conceptual limitation in the form of an explanatory word or at least a number. In the IDC system the parenthetic expression causes the computer to issue a message when the thesaurus is matched against the new storage tape, so that homonyms may be recognized and brought into an unambiguous form on the storage tape.

If thesauri of different scientific fields are to be compatible or used in different branches of knowledge, an additional overall check for homonymity is necessary.

5.3. Definition of concepts

As additional information on a concept, its definition is of great value. At least in cases where relationships are difficult to indicate, a definition should be worked out and entered into the thesaurus.

In the interest of practical documentation, concepts should be defined with general usage in mind rather than terminological standardization, however justified. Experience shows that most differences in the use of special technical concepts can be attributed to differences in the degree of abstraction of the underlying definitions. One author has a narrower, another a broader idea of the meaning of a concept. Because of the given scope of variation, it is of no use to fix unduly narrow definitions.

Taking all this into consideration, the following guidelines for a user-oriented definition of concepts result:

- o The definition of a concept should be as close as possible to the usage of the concepts in the literature.
- o In cases of doubt, the more abstract and comprehensive version is to be given preference in order to avoid loss of information during information retrieval.

5.4 Different kinds of concept relationships and their definitions

In order to describe concept relationships it is necessary to have an understanding of the different kinds of concept systems and the different types of relation concepts. Stimulated by a publication by WÜSTER[7] the terminology of the types of relation concepts has been completed and put to practical use in the IDC Thesaurus. A distinction is made between abstraction system /"Abstraktionssystem"/, whole-part-system /"Bestandssystem"/ and attributive or affiliation system /"Zugehörigkeitssystem"/, each having two reciprocal types of relation concepts.

Abstraction systems are characterised by broader concepts and narrower concepts. Narrower concepts have all the characteristics of the broader concept and in addition at least one limiting characteristic.

Whole-part systems indicate the relation between an entity and its parts and are described by total concepts and part concepts. Part concepts are arrived at by the mental division of a whole /total concept/ into its parts.

Example: "body", "chassis" and "engine" are part concepts of the total concept "automobile".

Attributive or affiliation systems are described by reference concepts and accompanying concepts. Accompanying concepts are closely related to their reference concepts, but do not coincide with them in their characteristics /no abstract relationship/, nor can they be formed by a division or dissection of their reference concepts /no whole-part relationship/.

Examples: "Catalyst" is an accompanying concept of "catalysis". "Distilling column" is an accompanying concept of "distillation".

These examples show that the attributive system includes important cross-references between different concept categories, as between a process and the function of a material, or between operations and apparatus, while in the abstraction system relationships are restricted to one and the same concept category.

In the system of concepts, abstract relations, whole-part relations and attributive relations appear simultaneously and penetrate each other. Therefore, if the order of the system is to be readily understood and the organization is to be convenient for retrieval purposes, it is important that the different types of relation concepts be identified and arranged in a logical sequence.

While in the abstraction and whole-part systems concept relationships result directly from the definition of the relation concepts, the direction of the relation in the attributive or affiliation system is obtained by logical interpretation of "affiliation". It is a characteristic of "affiliation" that it depends on and belongs to something else; the meaning of "affiliation" is that it refers to an object which can be named as a reference concept.

O	Broader Concepts	Abstraction System
U	Narrower Concepts	
S	Total Concepts	Whole-part System
T	Part Concepts	
X	Reference Concepts	Attributive System
Z	Accompanying Concepts	
G	Opposite Concepts	
V	Related Concepts	

Table 2 Kinds of relation concepts with abbreviation symbols of IDC Thesaurus

With compound concepts the situation is more complicated. A general rule for the assignment of concept relations is derived from the fact that compound concepts have been formed by either "determination" or "conjunction" or "disjunction" or "integration" /cf. 1/. Most common is the formation by determination, i. e. limitation of the original concept by the addition of a supplementary characteristic to the content of the original concept. In this case the basic word in the compound word is the broader concept. The explanatory portion is the reference concept or, if the relation between the explanatory portion and the compound word does not seem to be relevant for retrieval purposes, the related concept.

Example:
E Oxidation catalyst
O Catalyst
X Oxidation

Therefore: E Catalyst
U Oxidation catalyst

E Oxidation
Z Oxidation catalyst

It is, however, not always easy to distinguish between single concepts and compound concepts and if pre-coordinated, the type of formation is not always apparent.

Concepts for which it is difficult to determine the direction of the relation are characterised as "related concepts".

These are concepts that cannot be assigned to any of the other relation concepts and whose cross-relationship often consists in a somewhat remote mental association.

An unresolved problem is how to deal with overlapping. In the IDC Thesaurus overlapping is indicated by special references.

6. Outlook

The only way to avert the impending disaster in information handling is through international cooperation. What is required above all is agreement on the methods to be used. Efficient and future-oriented methods of documentation must be developed. It is being realized more and more that the efficiency of a documentation system depends upon the perfection of its conceptual system.

A thesaurus seems to be the best means to compile concepts together with all pertinent information and to generate a polyhierarchical system of concepts. The consistent use and precise representation of concept relations determines the quality of the thesaurus and its reliability in information retrieval.The problems of finding the right methods for constructing a thesaurus and the many decisions which are connected with the study of special concept fields have only been briefly dealt with in this paper.

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REMARKS ON THE PROBLEM OF THESAURI AND THEIR BUILDING

Maria Leska[x]

Definitions

1. A descriptor is a chosen formalised term, consisting of one or a few words or a determined symbol, forming an elementary part of the thesaurus, meant to represent in a univocal way the determined subject content, of equivalent terms or groups of terms.

2. Ascriptor — a term or qualification largely synonymous with the given descriptor. Ascriptors in the information retrieval system are replaced by corresponding descriptors, while in thesauri they indicate corresponding descriptors by means of a system of reference marks.

3. A thesaurus is an orderly, arranged quantity of notions and termini creating an open system of subject headings placed within the framework of a domain or a problem, classified, part of which consists of descriptors with indicative interdependences and their mutual conceptional relations.

Structural elements of a thesaurus

1. General scheme of groups and subgroups of descriptors.

2. Index /may be tabular/ of descriptors taking into account their mutual hierarchical dependences, semantic and functional connections, ascriptors etc.

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[x] Central Institute for Scientific, Technical and Economic Information, Warsaw.

3. An alphabetic index of all terms embraced by the thesaurus with cross-references showing the correlation of the terms, their mutual connections and the connections between descriptors and respective ascriptors.

4. Description of the system of cross-references applied in a thesaurus.

Note: A list of terms with neither structural information nor information about their mutual dependences is not a thesaurus, even if it has partly synonymous terms.

A thesaurus should as a rule cover fully the given domain or problem for which it was created. However, analysing existing thesauri and the literature concerning them, we can select two tendencies:

1 - a thesaurus should be adapted to a definite collection of information material and serve to make accessible the necessary information from the respective collection without either information "noise" or silence.

2 - a thesaurus should fully embrace the respective domain or problem, whether or not in the informational collection to which it is applied the materials are complete. Such a thesaurus would help in tracing the information gaps of respective collections.

The definition of a thesaurus is a problem which still demands discussion. It would be most advisable to define univocally the conception of a thesaurus, for which as we know there are numerous definitions. The importance of differences in the way of formulating may be here accepted as negligible; more important, even essential, are differences in the substantial understanding of this conception. A certain number of authors consider that a thesaurus is a kind of dictionary: ideological, or notional. In such cases the requirements given to the thesauri are limited to:

- obtaining a certain number of words of natural language chosen by analysis of the subject matter of texts and systematized according to an initially chosen classification system,
- obtaining an index of descriptors as a tool for a precise designation of content of the necessary information and enabling coordinate indexing of documents and informational inquiries,

- creating an orderly collection of key words chosen by statistical analysis of texts, no matter what subject.

The point of view does not sufficiently explain the still growing importance that is attached to the thesaurus, especially as to the information retrieval language in modern information systems and in studying modern methods of scientific information. There is a basic difference between a thesaurus and a dictionary. A dictionary is used to find words and terms, and a thesaurus - notions. We therefore cannot consider a list of terms which does not include structural information about mutual connections and dependences of notions as a thesaurus.

In the latest definitions a thesaurus is described also as a classification system. This view is interesting, but needs discussion. It is indispensable to designate what additional conditions should be accomplished by a thesaurus in order to be generally considered as a classification system independently of its main aim as an information retrieval language.

It seems that the reasons quoted above sufficiently justify the need of continuing further discussion.

Our experiences and the analytical and research work carried on while preparing a thesaurus of scientific information, show that certain classical methods are being formed: of choosing informational material for the thesaurus, of defining the scheme and its thematic range; principles of working out descriptors; the system of cross-references.

Each thesaurus still has special features which distinguish it from the others. This is due to the domain or problem for which the thesaurus has to be built, and to the concrete conditions in which it is worked out and applied.

The building of a thesaurus should be preceded by an accurate designation of the aim which it should serve and by the designation of available criteria of the quantity of notions, which were collected for building the thesaurus. The methodology of building the thesaurus depends also on the accepted definition of the thesaurus.

The first stage of work upon a thesaurus, the operation of collecting the optimal quantity of notions concerning the domain or problem is a classical stage, and there cannot be any possibility of avoiding it.

How varied the methods of collecting an assemblage of notions may be depends, however, on the range of the thesaurus.

- Considering that a thesaurus is adapted only to a designated collection of informational material, the quantity of notions may be formed by collecting key words and groups of words systematically from the documents of the respective collection.

- Assuming that the thesaurus should embrace a given domain or problem, it is necessary to construct - already as the first stage of the work - a semantic-hierarchical scheme of this thematic range.

Contrary to the first solution, when solving the problem as above, the operation of gathering notions and terms should not be based on one information collection, even on the best one. Such a collection and the materials embraced in it should be analysed systematically and very thoroughly. The results should be compared with other local and foreign collections of materials, with semantic-functional-hierarchic schemes of this domain or problem, theoretical ones as well as those based on experience. It is also necessary to investigate the largest possible number of information items - and retrieval systems of this domain or problem.

When the work on building the thesaurus in conducted parallel to the process of gathering information material /in the range of the domain or problem/, a third solution could be applied. It should be started with elaborating a theoretical semantic-hierarchic scheme. This scheme will be more theoretic than when building it on the basis of an existing and systematized collection. Such a solution gives the possibility of excluding, already at the design stage, materials only loosely connected with the basic thematics of the domain. And such materials are always to be found in every collection.

Gathering an amount of notions and termini should be realized on the basis of the natural language, embracing in the collection entries specific to the specialized language of the domain or problem and even if necessary terms originating from slang.

When planning analytical and research work on the fund of notions and terminological problems of the domain, the limits of this domain should be precisly defined.

It is especially important that the thesaurus should be built for the range of the domain, and not for the given collection.

The delineation of the scope of the domain for which the thesaurus should be built and the comparative analysis of existing semantic schemes of this domain and of related domains will be of evident aid when delineating the thematic range of the thesaurus.

The solve the problem of designing the optimal way of gaining access to the collected notions and termini, one has to classify the collection and to range the notions and termini according to the categories of the scheme. The goal of this operation is to find out the gaps in the fund of notions and termini and to correct and improve the scheme.

During this stage of the work it is already necessary to define the principles of utilising the collected mass of notions and termini in the thesaurus, and especially:

- the criteria of choosing termini to become descriptors,
- the principles of descriptor building,
- the principles of utilising synonyms, closely related words etc.,
- the principles of connecting descriptors with ascriptors.

These criteria and principles should enable the elaboration of a collection of descriptors and ascriptors showing their relationships. A tabular display with descriptors systematized according to the scheme of the domain or problem may be used here as an efficient tool.

The determination of the method of alphabetic ordering of descriptors and ascriptors is to be done in the next stage of the work. An arrangement in the form of a permutated index should be most effective as far as informative value is concerned. The system of cross-references should correspond to the hierarchic relationships of descriptors and their interconnections with ascriptors shown in the tabular display.

I do not intend here to discuss all essential problems arising when building the thesaurus - only the most essential elements.

The popularity of thesauri as information retrieval tools is still rising. This is evidently a sign of their usefulness. Nevertheless the difficulties bound up with elaborating thesauri are great. Although the methods of building thesauri are still more precise, it is impossible to build a thesaurus following precisely these methods: each thesaurus has its own problems, and demands modification and complementation of the method. In order to master all these difficulties it is necessary to collect experiences. This may be done by means of publications devoted to the direct exchange of know-how and of experiences concerning the theory of building thesauri as well as their practical application. So far, experiences on the efficient use of thesauri as retrieval tools have been amassed on the basis of a very limited number of thesauri. Such experiences help to evaluate the thesaurus in its role as:

- a vocabulary of notions enabling the correct indexing of documents,
- an information-retrieval tool,
- a classification system.

It seems also of importance to discuss how the development of thesauri will influence the development of scientific information theory. It is also to be desired that the development of the theory and principles of thesauri building will eventually reach the stage of universalization and internationalization.

PRINCIPLES OF THESAURI BUILDING

K. Leski[x]

The concept of thesaurus that I propose is intended to embrace all thesauri, not only those built for domains with already highly-formalised languages /as in technology, the exact sciences etc./.

x

1. The concept of a thesaurus as an element of a retrieval system

The goal of building thesauri is to obtain a univocal way of qualifying the content of documents and of their retrieval. The univocal character should be achieved in what concerns thematics and organisation on a possibly large scale. The range of thesaurus thematics should therefore be as wide as possible, and it should embrace all the collections of materials from this domain.

The optimal thesaurus should therefore - theoretically - comprise the whole of human knowledge and should be applied to all retrieval systems.

At the present development stage this is not possible, for several reasons. One could say that it is rather likely that such a stage will never be reached. While a necessary precision and univocal character of the terminology, the identity or at least the semantic and functional similarity of terms examined from all points of view, will be achieved, the knowledge of laws governing the living languages will probably increase so that it will be possible to organize the retrieval systems on different bases and with the aid of tools more efficient than the present ones.

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The conclusion concerning the range that respective thesauri have to cover is that they should comprise the ranges of subjects where the respective elements of the thesaurus are looked upon from one point of view.

Such ranges are practically represented by respective fields of science, and thesauri should therefore be adapted to their frameworks.

There are no limits to the organizational reach of the thesauri. It is languages only which may form such barriers: the relations between the notions in various languages that were formed in different cultural conditions may be differentiated; therefore translating notions from one language to another may cause either great informational "noise" or silence.

Within the frames of one language or one domain such a danger doesn´t exist. We can assume in such conditions that a thesaurus should comprise the range of a full domain of science and in these frameworks, all the collections applying retrieval systems based on methodological tools worked out in the given language.

The thesaurus cannot present an inflexible construction - stiff, closed and fossilized. It must be receptive to the inflow of new notions covering new problems, be amenable to the removal of out-of-date terms, and be able to absorb changes of meaning in the descriptors. It must therefore present an open system.

The thesaurus must ascertain an almost automatic passing from terms embraced by a certain problem to other problems connected semantically and functionally.

It must therefore reveal the relations between the terms comprised /or between notions represented by these terms/.

As result of this reasoning /obviously abbreviated here to fundamental elements/ the thesaurus may be defined as follows: "An open system covering a determined full thematic range containing an ordered number of terms, some of which are admitted as descriptors, showing the relations occuring between these terms and their mutual dependences".

Such a thesaurus consists of 2 categories of terms: descriptors and other terms. The thesaurus cannot exist without these terms.

Theoretically, we can assume that a thesaurus can embrace all the semantically-precised terms from a certain domain. Evidently such a multitude of terms would be too numerous and as a consequence such a thesaurus would cause a lot of information noise or silence, and above all its application would involve much difficulty. The thesaurus must therefore embrace only some such terms, and only those where the level of generality will be high enough.

Among these terms may appear some groups with semantically close meanings etc., therefore there won't be any necessity of applying all these terms. It will be advisable to choose terms representative for such groups. The method of building such terms cannot be quite free - they must be subordinated to some common rules.

While applying these terms it is not possible to refer to the whole thesaurus each time in order to find their mutual relations. These relations, at least the most important, must be indicated directly by each of them. The most effective way of doing this is by means of cross-references.

All the terms cannot be applied operatively while they can be met within the given thematic range, and therefore their roles must be determined in the thesaurus. Thus we come to the definitions of fundamental elements of the thesaurus: descriptors and ascriptors.

A descriptor is a "chosen formalized term, built of one or a few words or a symbol, making an elementary part of the thesaurus intended to represent in a univocal way the determined subject content, with pointing out its basic relations and dependences with other descriptors and ascriptors".

An ascriptor is "every term included in the thesaurus, but not a descriptor, being one of the synonymous terms, or one close in meaning in relationship to one descriptor comprised by the thesaurus".

2. Structural elements of a thesaurus

The abovementioned way of comprehending the essence of the thesaurus and its elements creates special requirements for its construction. As a consequence, such a thesaurus should comprise:

a. A general scheme of groups and subgroups of descriptors.

b. A tabular display of descriptors, showing their mutual hierarchic dependences, their semantic and functional relations, ascriptors etc.[1]

c. An alphabetically permutated register for all terms applied in the thesaurus, indicating their mutual relations by means of cross-references.

Such a register may be divided into separate lists of descriptors and ascriptors.

Besides the above forms of presenting a thesaurus, the relations between the terms applied in it may be presented by other methods. However a system which does not comprise the forms mentioned above will not be a thesaurus.

3. Elements influencing the organization of the thesaurus

The abovementioned structural elements of the thesaurus determine its external shape. Its subject content, and as a consequence its organisation, depend on:

a. The thematic range comprised by the thesaurus and its semantic content.

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[1] The tabular display of descriptors, realised according to the scheme comprising all dependences and relations of each descriptor /encl.1/, fulfills two roles simultaneously: of a material enabling a clear and full picture of these dependences and relations and of the analytical apparatus, controlling the building of the scheme of groups and subgroups of descriptors. The subject division of the thesaurus can also be established in another way, but the already-mentioned analytic method appears however to have many positive aspects; above all it eliminates various interpretations.

b. The assumed degree of minuteness of the thesaurus, closely connected with the method of operating the thesaurus.

c. The overlapping of the thematic ranges in the thesaurus with other thematic ranges.

d. The clearness and terminological precision of the thematics embraced by the thesaurus, and as a consequence the method of choice and building descriptors.

4. Building of the thesaurus

A thesaurus should be built so as to ascertain as full an analysis as possible of its thematic range. Its thematic range should be therefore determined and presented in the form of a semantic-hierarchical scheme.

Such a scheme should then be filled with subject entries collected on the basis of analysis of documents entering within the range of the planned thematics, books and periodicals, published and not published, of inquiries addressed to the collection and of different types of analyses of frequency and means of appearing in the documents of those entries.

Filling the scheme should be followed by correcting and improving the established semantic hierarchical scheme. A very important stage in the building of a thesaurus is to work out which ranges it has in common with other thematic ranges. These will be the ranges through which will take place the flow of information between the thematic range of the respective thesaurus and neighbouring thematic ranges. While analysing the subject entries appearing in these ranges, it is necessary to look at them from two points of view /or more/ of the overlapping subject ranges. Similarly, we should approach the choice and building of descriptors in two or more ways, establishing their relationships etc. Great help can be provided here by an accurate building of tabular display of descriptors.

5. Language barrier

In item 1 I have mentioned the language barrier as limitating the reach of organisational application of the thesaurus. Such barriers undoubtedly exist and overcoming them will always be difficult, but may not be impossible.

It is obvious that the semantic contents of respective subject entries, and as a result of descriptors, sometimes differ from one language to another.

The semantic hierarchical arrangements of these entries and descriptors, as well as of their mutual connections and correlations, the synonyms and homonyms etc. are differentiated.

When passing from the system of a thesaurus built for one language to such a system in another language, it is necessary to consider carefully all these differences and create thesauri common for these languages. There will evidently be no possibility of obtaining in this case a very high level of conformity of descriptors and their arrangement. It is to be assumed that the precision and minuteness of a multilingual thesaurus will be somewhat limited.

The degree of conformity will here be the function of all these factors and probably a result of their given interpolation.

6. The role of the thesaurus

In item 1 I limited the role of the thesaurus to the role of an element, a tool in the information-retrieval systems.

Such is probably the contemporary role of the thesaurus. But is it the only role? Such a limitation would not be right. A properly-built thesaurus is meant first of all to qualify documents, and later to retrieve then. Even at this first stage another possibility of utilising a thesaurus reveals itself: analysing the content of documents with the help of descriptors, and in consequence breaking up these documents into microelements, classifying these microelements and determining their mutual correlations. The question arises of whether the thesaurus we are building now will perform the role of an instrument for such an analysis, or whether another type of thesaurus will originate from the objective systems of documents in the given domain.

7. The correlation of thesauri

According to the above reasoning, it seems that there is the possibility of a free flow of information from one thematic range embraced by one thesaurus to another thematic range. Such a result may be achieved through:

a. Agreement on understanding the essence of the thesaurus.

b. The unification of requirements from a thesaurus, concerning necessary structural elements for its existence and ways of building thesauri and descriptors.

c. Paying particular attention to overlapping thematic ranges common to interrelated thematics and examining the descriptors embraced by these ranges from all possible points of view.

d. Making thorough comparisons of thesauri systems with the same /or similar/ thematic ranges, but in different languages, and building bi-lingual or multilingual thesauri.

Satisfying the above conditions should ascertain the correlative character of newly-built thesauri.

In order to achieve a similar result in relation to existing thesauri, it is necessary to analyse thoroughly their ranges common with other domains and thesauri - if possible also adapting descriptors created for these ranges.

Though the new possibilities of using thesauri as instruments for analysing the contents of documents /item. 6./ do not seem to have a direct influence on their mutual correlation this aspect of the problem deserves close attention nevertheless.

Tabulary Display of Descriptors

Encl. 1

	The examined descriptor	1
	The definition-designation of the examined descriptor	2
	The descriptor of directly broader content	3
	The head descriptor of the group	4
	Descriptors subordinate directly to the examined descriptor	5
	Descriptors associated with the examined one as to subject and function	6
	Head descriptors of descriptors associated with the examined one	7
	Other domains of science with which the examined descriptor may be related	8
	Synonyms of the examined descriptor	9
	Homonyms of the examined descriptor	10
	Terms close to the examined descriptor	11
	Resulting ascriptors	12

REMARKS ON THE GENERAL PRINCIPLES OF THESAURI BUILDING

Imre Molnár[x]

1. Hierarchical and alphabetical thesaurus

Ordered collections of the terms of human knowledge, which contain an enumeration of concepts, as well as their interpretation and relations, are named thesauri. This definition includes a few elements which need further explanation.

1.1. Ordered collection of terms

As shown by the title, the appraisal of human knowledge can be realized by collecting the terms, on the one hand, and the systematization as a condition for a collection of terms designated as a thesaurus, on the other. A thesaurus may be constructed in several ways, using different principles of arrangement. A thesaurus compiled for a certain purpose owes its particular structure to the general relation between structure and function. Besides, the developmental stage of the thesaurus is also a factor determining the structure. A thesaurus has differently structured forms in the course of its development. In general in might be said that the first and fundamental form of thesauri is the hierarchically-arranged structure. This form reflects the subordination of science. The hierarchically-ordered thesaurus gives an interpretation of the correlation of terms in a particular branch of science, and makes possible an appraisal-in-depth relating to special questions of different scientific problems.

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[x] Library of the Hungarian Academy of Sciences, Budapest

If a thesaurus has the function of gathering all possible concepts of a discipline, the hierarchically-ordered form is best suited to this task.

A thesaurus considered as an instrument of information systems can hardly be effective in the hierarchical arrangement. The hierarchically-ordered list of terms is not suitable for information analysis, indexing, storage or retrieval of information. These problems may only be solved by alphabetically-arranged thesauri. The hierarchical structure of a thesaurus compiled for information work is only the first step to the final, alphabetically-arranged form. The hierarchical thesurus remains, of course, a necessary instrument of a complete thesauri-system because only this type of thesaurus is able to give adequate answers to such questions as these:

Are the terms of a branch of science sufficiently detailed?

Are the markings of different correlations of terms suitable?

Does the thesaurus contain synonyms, homonyms, etc. in a necessary quantity?

Does the thesaurus contain a certain new term? If so,what kind of relations does that term already have?

Thesauri which are used in the routine work of information systems and are often born during continuous information work, are employed in alphabetical form. By its mechanical arrangement, as well as by its codes for relations of terms and by its homonyms separated and synonyms connected by code signs, the alphabetically-arranged thesaurus provides an efficient instrument for the indexing of documents, for information storage and retrieval, and also for standardization of information queries.

There are many possibilities of marking the hierarchical level and semantic relations of included terms in the alphabetical thesaurus. The codes connected with each term of the thesaurus are able to represent and mark the class of terms which the actual term belongs to.

This is shown by a detail of a biochemical thesaurus.

Hierarchical arrangement		Alphabetical arrangement	
12	Protein	Dehydrogenase	1211
121	Enzyme	Enzyme	121
1211	Dehydrogenase	Lactate-dehydrogenase	12111
12111	Lactate-dehydrogenase	Protein	12

Both the code number of every term and the number of digits of a code number have a definite meaning relating to the hierarchy of terms.

1.2. Human knowledge

Thematically, the main types of thesauri are: general and special thesauri. The type of a thesaurus is thematically defined by the size of the branch of science which the concepts belong to. The limitation of different disciplines and of their terms seems to be one of the most exciting questions of thesauri building.

The completeness of the terms of a discipline is always relative, the limits of a branch of science can be differently appraised in depth.

1.3. Interpretation of terms

Every term in a thesaurus must have its exactly-defined and characteristic meaning. Therefore, terms must be interpreted exactly. This interpretation may be different in size: it may include only the meaning of the terms but it may also contain synonyms, related terms, etc. It is also advisable to interpret whether a term is a descriptor /indexing term/ or only a subject-heading /no indexing term/.

The criterion of unanimity requires, in the first place, the separation of homonyms. The use of brackets is a frequent method of making the necessary distinction between the different meanings of a homonym.

1.4. Marking of relations

Semantic correlations mark the hierarchical level of terms in a thesaurus. The relations lead from a generic term to a specific one and vice versa. The most frequently used relations are as follows:

Broader term	/BT/
Narrower term	/NT/
Related term	/RT/
Use	/USE/
Used for	/UF/

The sufficient marking of both the hierarchical level and the relations of terms in a thesaurus ensures that the required depth in the indexing process is achieved.

2. Thesauri in information systems

Information systems and the indexing process frequently result in a thesaurus. However they always have a significant feed-back to the thesaurus. An information system can only be effective if it corresponds with the continuous and rapidly-changing information needs. This is why any one branch of science needs a special thesaurus for the use of a certain institution, for the different depth of information queries. A research problem of a discipline may be of more importance in one particular place than in another. The dispersion of usage of certain terms is the greatest in borderline sciences. An institution which studies a problem regarded as an important one analyses its terms in a more detailed way than another which tends to investigate this problem only peripherically, and uses its terms only in a more general break-down.

This situation leads to the atomization of the methods and techniques of thesaurus building. And this atomization has no negative character in general. For all the institutes, research laboratories, enterprises, etc. it is a duty and a necessity to build their own thesauri which must correspond with the information needs in their own organization.

This development offers fewer and fewer opportunities for thesauri which tend to cover the entire range of human knowledge. The rate of the production and specialization of information makes it more and more urgent to build thesauri, relatively narrow in volume and analytically deep in appraisal.

These thesauri may be compiled and structured in a variety of depths, sizes, forms, etc.

On the basis of the abovementioned arguments, all the principles, facts, methods and techniques elaborated and made usable for thesauri building are today very valuable and necessary. Preparation of data, methods, techniques and designs is the greatest help experts of thesaurus research may give to the specialists of information systems.

3. General thesaurus, special thesaurus

The construction of a thesaurus requires a comparatively long time, and time is also the destiny of the thesaurus. As a consequence of the acceleration of scientific development, the division of the individual disciplines and the semantic range of the terms will be transformed, will broaden out or will become narrower, but in certain cases they may cease.

The division of the content of terms causes most problems, often those most difficult to solve. A scientific problem which was expressed during a certain period by a single descriptor may function in the future as the content of several descriptors.

This process makes for a rich system of cross-references; however this richness later becomes pullulation, which makes the system at first cumbersome, and finally useless.

As a consequence of the abovementioned process, thesauri must be rearranged periodically. A thesaurus can be expanded during a relatively long interval; this possibility has, however, a decreasing occurrence in time. The possibility of expansion is inversely proportional to the growth of a thesaurus.

In general, thesauri have a retrospective character. The larger the thesaurus is, the greater is the validity of this statement. Computers may result in a significant time-saving in the compilation of very large thesauri; there is, however, much to do which is not mechanizable on computerizable, and these tasks require long and skilled labour so that the thesaurus will be retrospective anyway.

The larger the volume of a thesaurus, the harder the problem of its application to modern and analytical information needs, owing to the inevitably poor representation of the emerging new scientific fields of our days.

It is important to make efforts to build thesauri for the individual branches of science. The building of relatively small thesauri is always more economical than that of larger ones. This is why I feel it necessary to interpret the basic principles of thesauri building according to the size of different types of thesaurus.

НЕКОТОРЫЕ ПРОБЛЕМЫ КОНЦЕПЦИИ ТЕЗАУРУСА

Some General Problems Concerning Compilation of Thesauri

Vitězslav Maixner[x]

Введение

Одним из основных теоретических познаний информатики за последние годы является, безусловно, факт, что тезаурусы следует рассматривать как составную часть поисковых языков, причем нельзя упускать из виду значение /роль/ соответствующего грамматического описания. Поэтому было бы неправильным заниматься проблематикой построения тезаурусов, не выяснив некоторых элементарных понятий из типологии поисковых языков.

Однако типология поисковых языков не является главной темой доклада. Поэтому мы ограничимся тем, что приведем несколько рабочих определений из этой области, не претендуя на точность, и затем перейдем к основной проблематике.

Синтаксическо-семантические отношения

Под синтаксисом поиского языка мы здесь подразумеваем любую систему формальных и лексически-формальных средств, четко установленную и общепринятую в описании данного поискового языка /ПЯ/, поскольку эта система дает возможность обозначать семантические /смысловые/ отношения между дескрипторами, составляющими комплексное тематическое описание документа. Для данного ПЯ с синтаксисом существует именно одна такая синтаксическая система, помогающая определить множество правильных комплексных тематических описаний на данном языке.

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[x] Central Office of Scientific, Technical and Economic Information, Prague.

Формальными синтаксически-семантическими средствами ПЯ являются, например, скобки, соединительные знаки, различные знаки препинания, семантически релевантный порядок дескрипторов и т.п.

Лексически-формальными синтаксически-семантическими средствами ПЯ являются, в частности, специальные дескрипторы, соответственнно обозначенные в тезаурусе, лексическое определение которых дополнено четкими правилами их синтаксической функции.

Лексические синтаксически-семантические средства неформального типа, будь то целесообразно выбранные или случайные /комбинация дескрипторов для данного случая/ могут изредка полностью или почти однозначно определять отношения между дескрипторами в каком-нибудь конкретном комплексном описании документа. Однако в данном случае не всегда можно говорить о синтаксисе /это не является достаточным условием/.

Использование семантики в ПЯ без синтаксиса, как косвенно следует из предыдущих приблизительных дефиниций и рассуждений, направлено, преимущественно, на системно-лексическую /тезаурус/ и прикладную /индексирование, формулировка поисковых запросов/ области.

При переходе к ПЯ с синтаксисом естественная проблема относительной однозначности описания документа попадает частично в плоскость синтаксическо-семантических отношений /в общих чертах сравнимой с синтаксисом прадложения и семантикой предложения естественных языков/.

Проблематика системно-лексического характера /создание тезауруса и его пересмотр/, в основном, присуща поисковым языкам с синтаксисом и без синтаксиса. Однако требования к объему тезауруса /это касается, в первую очередь, количества дескрипторов и определенных лексических сочетаний/ смогут быть, в результате внедрения целесообразного синтаксиса, значительно сокращены.

В некотором смысле можно сказать, что в сравнимых по качеству случаях применения /эффективность поисковой деятельности/ функцию тезауруса перенимает отчасти синтаксис. Синтаксис, лишенный такой компенсационной функции, явился бы неизбежно неэффективным усложнением поиского языка.

Аналогичное взаимнокомпенсирующее отношение можно предположить между функсиями формальных и лексико-формальных средств в синтаксических системах.

В настоящее время существует уже большое количество поисковых языков с синтаксисом, которые отличаются друг от друга хотя бы в формальном отношении. В целях нашего ориентировочного обзора введем сначала следующую общую классификацию, выдвигающую семантические аспекты синтаксиса:

I/ ПЯ выражающие лишь степень взаимосвязи между дескрипторами в комплексном описании документа

2/ ПЯ выражающие лишь функцию /роль/ отдельных дескрипторов в комплексном описании документа

3/ ПЯ выражающие и степень взаимосвязи, и роль дескрипторов

4/ ПЯ выражающие взимосвязь между дескрипторами в комплексном описании документа более явно, чем ПЯ, указанные в пунктах I-3.

Если мы, наоборот, подчеркнем формальные аспекты синтаксиса, по своему характеру более или менее второстепенные, то можно различить следующие его релевантные знаки с признначными или бесризначными вариантами:

а/ лексичность
б/ позиционная релевантность
в/ формально-символическое обозначение отношений.

Если мы предположим полную сочетаемость призначных и беспризначных вариантов а/, б/ и в/ и учтем комплексным образом семантические и формальные аспекты, то мы легко придем к заключению, что для вышеуказанной ориентировочной классификации можно теоретически образовать 32 различные типовые комбинации ПЯ с синтаксисом. Комбинация исключительно беспризначных вариантов а/, б/ и в/ ввиду данного определения ПЯ с синтаксисом бессмысленна, и поэтому максимальное число типовых комбинаций ПЯ следует сократить до 28. Но количество осуществленных типовых комбинаций, по всей вероятности, находится под этой теоретической границей.

Семантические проблемы составления тезаурусов

Литература, занимающаяся методикой составления тезаурусов, сравнительно доступна. Специфичность понятия "тезаурус" различными авторами толкуется по-разному. В нашем докладе мы имеем в виду лишь те тезаурусы, дескрипторы которых находятся в прямой формальной связи с лексическими единицами какого-либо естественного языка.

Общеизвестно, что на практике составление тезаурусов является очень трудоемкой работой, которую можно схематически разделить на три этапа:

I/ подбор источников
2/ составление тезауруса
3/ испытание и пересмотр.

В следующих замечаниях мы попытаемся изложить в общих,теоретических чертах эту методику, с точки зрения семантики ПЯ:

К п. I/ Собрание терминологических материалов, на котором в конкретных случаях базируются, является, принимая во внимание мировую библиографию терминологических публикаций по данной тематической области, всегда неизбежно случайным и неполным. Влияние этого исходного материала, естественно, очень значительно, хотя и желательно, чтобы оно было подчинено единой концепции построения тезауруса. Наиболее благоприятен был бы, по-видимому, такой ход работ, при котором бы отбор материалов проводился в соответствии с заранее разработанной четкой концепцией.

К п. 2/ На этом этапе отсутствие четкой концепции следует рассматривать как серьезный недостаток.

Разработка такой концепции предусматривает наличие:

I/ грамматического описания ПЯ, по которому можно определить приблизительную типовую характеристику ПЯ и основные правила индексирования и формулировки поисковых запросов;

2/ основных сведений о справочно-информационном фонде - об его объеме, среднем годовом приросте, тематической структуре, о преобладающем методе обработки документов и поисковых запросов

а/ в среднем за несколько последних лет
б/ в перспективном развитии на ближайшие годы.

Концепция построения тезауруса должна содержать:

А/ Определение главных семантических областей тезауруса, иногда также подбор главных лексических дескрипторов /как правило, лишь один дескриптор для определенной области/;

Б/ Диапазоны количества дескрипторов для всего тезауруса и для отдельных семантических областей;

В/ Возможное определение, в соответствии с типом ПЯ, основных формально-лексических дескрипторов;

Г/ Установление всех типов ссылок, которые будут последовательно применяться в тезаурусе;

Д/ Приблизительное определение объема, в каком будут приводиться фразеологические сочетания /соразмерно с количеством дескрипторов/.

Такая концепция, поскольку она приблизительно соответствует предпосылкам I/ и 2/, указанным выше, должна была бы представлять в положительном смысле ограничивающий подбор факторов, облегчающий практическую работу над составлением тезауруса и сигнализирующий возможные ошибки и ошибочные тенденции в ходе этой работы.

Однако в настоящее время об адекватности концепции можно судить, как правило, только "ex post", т.е. после экспериментального испытания тезауруса, что, безусловно, не является идеальным положением. Путь, надежно ведущий от предпосылок к достаточно адекватной концепции, должен был бы быть в максимальной мере подготовлен информационными теоретиками. Но пока нам остается констатировать далеко не радостную действительность, что пока в этом направлении не было в мировом масштабе почти ничего предпринято.

Примечание I. Вышеприведенный методический принцип можно вкратце выразить так: грамматическое описание ПЯ и характеристика СИФ-а приблизительно определяют концепцию тезауруса. В более общей плоскости можно было бы это интерпретировать как некоторое заведомо использование взаимоотношений между грамматическим описанием ПЯ, характеристикой СИФ-а и структурой тезауруса. С формально теоретической стороны, т.е. если не принимать во внимание методические проблемы на практике, можно рассматривать любой элемент этой троицы в зависимости от остальных двух элементов, что можно схематически записать так:

I/ ПЯ = f/F, T/
2/ F = g/ПЯ,T/
3/ T = h/ПЯ,F/.

Мы пока явно рассматривали только отношение 3/, но мы не утверждаем, что отношения I/ и 2/ всегда теряют на практике значение.

Из отдельных пунктов вышеприведенной схемы концепции составления тезауруса вместе с предпосылками о ПЯ и СИФ-е вытекает:

из А основная ориентация семантической структуры тезауруса
из Б степень сокращения синонимических кругов исходного естественного языка
из В редукционная обратная связь со всеми главными семантическими областями тезауруса /потенционально обуславливающая более высокую среднюю способность комбинаций дескрипторов/
из Г редукционная обратная связь со всеми главными семантическими областями тезауруса /потенционально обуславливающая уточнение местной семантической структуры тезауруса/
из Д обратная связь со способностью комбинаций дескрипторов и уточнение местной семантической структуры.

Примечание 2. В случаях В, Г и Д редукционная обратная связь может проявляться, в частности, в тенденции к уменьшению количества дескрипторов /а/или в тенденции к упрощению определений дескрипторов.

Примечание 3. Уточнение местной семантической структуры в случаях Г и Д может проявляться, в частности, в дополнении определений или небольших семантически связанных групп с помощью отношений синонимичности, иерархичности или контекста.

Поправки, проводимые в тезаурусе, могут находиться в рамках заранее разработанной концепции или, в крайнем случае, представлять существенное изменение первоначальной концепции /поскольку она вообще была ясно сформулирована/.

Не претендуя на полноту, систематичность и единообразие критериев можно различать следующие типы изменений:

I/ объединение, разделение, исключение или дополнение в системе основных семантических областей

2/ изменения в иерархической структуре внутри какой-либо основной семантической области /без изменений в соответствующем неупорядоченном множестве форм дескрипторов/

3/ введение или исключение дескрипторов с последующим изменением иерархической структуры.

Экспериментальное испытание функции тезауруса, спорадические исправления, дополнения и запланированные систематические пересмотры всего тезауруса или семантических областей служат одной цели: чтобы семантическая структура лучше соответствовала характеристике фонда в его развитии и данному грамматическому описанию ПЯ. Однако роль тезауруса не должна быть в этом смысле всегда только лишь пассивно приспособляющейся. Стабилизированная или относительно устойчивая структура тезауруса оказывает существенное влияние на некоторые параметры СИФ-а, в частности, на его разделение по различным классам частотности. Можно даже предвидеть такой случай, когда оптимализированная семантическая структура тезауруса вместе с характеристикой СИФ-а будут подсказывать необходимость изменения грамматического описания ПЯ или выбора другого ПЯ /существенное изменение может быть равносильно выбору отличного по типу ПЯ/.

Заключение

Настоящий доклад ставил своей целью вкратце обрисовать некоторые основные проблемы построения тезаурусов с общей точки зрения. Ясно, что многие из этих проблем заслуживали бы более детального специального изучения. Пока в нашем распоряжении не много таких работ, и остается выразить надежду, что теоретики по информатике уделять им в ближайшие годы больше внимания.

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Резюме

Тезаурусы, находящиеся в прямой формальной связи с лексическими единицами какого-либо естественного языка, рассматриваются как частьселекционных языков, типология которых кратко намечена. В общей плоскости учтены отношения между грамматическим описанием поиского языка, структурой справочно-информационного фонда и структурой тезауруса. Приведены некоторые основные элементы концепции для построения тезаурусов и указано влияние этой концепции на структуру тезауруса.

Some General Problems Concerning Compilation of Thesauri

Summary

Thesauri, based on a direct formal correlation with lexical units of a certain natural language, are conceived as integral parts of retrieval languages, the typology of which is briefly presented. Special attention is devoted to some general aspects of the relations to be found between a retrieval language grammar, file structure and structure of the thesaurus. Some principles directed towards a controlled compilation procedure are proposed.

STATISTICAL ANALYSIS OF DOCUMENTATION FILES - SADF

Josef Mojžíšek[x]

Statistical analysis of a documentation file is carried out by two special computer programmes.

The first programme is used to test the distribution of documents in the file as well as exploitation of the file in retrieval requests, the aim being to modify the classification system and thus also the file structure in such a way, that it may become more suitable for manual storage and retrieval.

The print-outs of the second program /they are 3 in number/ provide much lucid information on the documentation file or on its manageable sample, which is used as input data.

The processing of documents consists in assigning one or more simple indexing terms /further SIT/ to each document. The group of SIT´s is called retrieval document description /further RDD/ - FIG. 1 A.

The whole RDD punched on a tape serves as input data for each document entering the analysis. The computing system is so arranged as to allow simultaneous processing of up to 10,000 documents. - FIG. 1 B.

As the result of data processing we get 3 output print-outs and some other information.

The first print-out is called a "Table of simple indexing terms" and it is used as an auxiliary table to ascertain an unknown rank for a known SIT. - FIG. 2.

The second print-out is called "Survey of SIT functioning". It is divided into blocks, each block being reserved to one SIT. Columns 1-10 involve only the given SIT and columns 11-14 show the relation of the given SIT to the so-called concurrent SIT´s, which are in combination with it. - FIGS.3 and 4.

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[x] UVTEI, Prague.

In this second print-out there is the concluding information:

- average number of RDD´s
- average number of concurrent SIT´s - FIG. 5.

The last - the third print-out - "RDD Frequency list" - characterizes individual RDD´s. It consists of pairs of lines:

- in the upper line there is the RDD written in full - here the RDD is composed of four SIT´s
- in the lower line there are 12 columns to be distinguished: See FIG. 6.

The last five columns 8-12 contain ranks of SIT´s written in the upper line, which participate in the given RDD.

This 3rd print-out gives the following information:

- average number of documents indexed by one RDD
- average percentage of documents indexed by one RDD
- and average increment of entropy - not yet evaluated - FIG. 7.

A special print-out gives the following very important data:

- number of occurrences of all SIT´s
- number of all processed documents
- number of SIT types - FIG. 8.

Evaluation of Output Print-outs

The output print-outs offer us rich, well-arranged information on the document file, or more exactly on the processed sample. They present an objective picture of the structure of the file. The data obtained can be used in many ways, such as for the revision and improvement of the indexing system, for the objective ascertainment of principal and peripheral problems of the file, for the compilation of a thesaurus and so on.

The relation between rank and frequency or accumulative frequency is given by the table in FIG. 11, which is in fact an extract from the "RDD Frequency list" - /3rd print-out - FIG. 6/.

Graphical representation of this table is in FIG. 9.

The axis of ranks is expressed on a logarithmic scale /see interval 1-1703/ so that we can study individual sections of the curve.

The real course of the curves can be seen in FIG. 10,where both scales are linear.

When determining the relation of the length of RDD´s to their frequency /i.e. to the size of equivalence classes/ we shall work with a new notion of an iso-frequency group.

In order to determine this relation the table in FIG.12 was compiled.

Each iso-frequency group is identified by two characteristics:

- by the RDD frequency of this group - for instance 24 /framed/
- and by the interval of the RDD ranks belonging to this iso-frequency group.

The purpose of the method is the analysis of RDD´s by their length, i.e. we try to ascertain how many SIT´s compose RDD´s belonging to individual iso-frequency groups.

The diagram in FIG. 13 graphically presents the left part of the table in FIG. 12. Each iso-frequency group is divided, in a linear way, into subgroups by different RDD lengths, i.e. by the number of SIT´s involved in the RDD.

The diagram indicates how many iso-frequency groups exist, the number of RDD s included in each group, and frequencies of individual RDD´s as well as their distribution by length in each iso-frequency group.

The values in the right-hand part of the table in FIG. 12 are the basis for plotting the diagram in FIG. 15, which is a graphical representation of analysis regarding RDD frequencies. This diagram demonstrates the relative parts of the file included in separate iso-frequency groups as well as the distribution of these groups by the length of RDD´s. It can be used as a nomogram. It presents, also, how the file is distributed into RDD´s by their length.

The analysis, the result of which indicates the combination power of indexing terms, starts from blocks for individual

SIT´s - we process columns 8 to 14 of the second print-out "Survey of SIT Functioning". - FIG. 3.

Then in the third print-out we gradually find RDD´s with ranks given in front of horizontal lines - examining columns 8 to 12 and marking by circles those SIT´s that are participating in particular RDD´s.

As an example the following block of SIT with rank 73 - FIG. 21 - was processed.

A graphical display is to be found in diagrams in FIGS.22 to 24.

These investigations will allow us to learn a great deal about related terms or descriptors /SIT´s/.

It is probable that the needs of practice would lead to the alternation of programme to the end that it might offer the maximum of useful information in the most convenient form. The proposed methods of the second programme regard only the analysis of a document file, although we know that the programme could also be used for the evaluation of the set of retrieval requests.

NOTE
All Figures see in the Annexes

COMPILATION OF THESAURI FOR USE IN COMPUTER SYSTEMS

Loll N. Rolling[x]

I - Introduction

A thesaurus can be defined as a structured vocabulary for use in information storage and retrieval systems.

Three parts of this definition need further elaboration:

1. A vocabulary is a collection of terms.
2. The structure of a vocabulary can be described as a set of relationships between terms.
3. Utilization of a thesaurus in an information system involves a set of rules which take into account the characteristics of the system.

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1. There are three types of thesauri according to the type of terms they consist of.

A few of the earlier thesauri consisted solely of uniterms/1/, i.e. single words. Some of these acquired significance only in combinations. Even simple concepts had to be represented by a combination of uniterms.

Many thesauri are of the "uniconcept" type. Uniconcepts can be either uniterms or polyterms, i.e. single words or combinations representing simple concepts.

Frequently co-occurring uniconcepts and uniterms can be combined to form pre-coordinated terms of the "subject heading" type. Most of today's thesauri comprise both uniconcepts and phrases representing a pre-coordination of two or more concepts, which could be called "polyconcepts".

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[x] European Community, Luxembourg

It is generally accepted that the vocabulary of a thesaurus should be homogeneous. However, there are a few exceptions. The thesauri of the USAEC/2/ and MEDLARS/3/, for example, which are generally of the "subject heading" type, comprise a limited number of uniterms /called "subheadings"/ to be used only as role indicators as it were in combination with the main headings.

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2. There are three classes of relationships between the terms of a thesaurus.

The "optional" or "indicative" type is represented by the crossreference A see also B, which invites the indexer in the process of assigning term A to see whether term B is not also relevant.

Also of the optional type are the RT /related term/, NT /narrower term/ and BT /broader term/ relators now in use in most of the English-language thesauri. The NT relator invites the indexer to check whether he should not be more specific. The BT relator suggests that the concept to be indexed might have a wider coverage than the main entry consulted.

The "compulsory" type is represented by the reference A use B. In many thesauri this means that term A must not be used and term B assigned instead /"exclusive" reference/. Term B is then either a preferred synonym or an abbreviation, or a spelled out version of term A. But it could also mean that term B should be assigned in addition to term A /"complementary" reference/. Such "complementary" references are mostly "generic" references from a specific term to a term of a higher hierarchical level, and the additional assignment of term B is called generic posting.

In a thesaurus where exclusive and complementary references co-occur, it is necessary to tag them with different symbols or relators.

A use B must be distinct from A use also B or A add B

A third class of relators is necessary to represent the "alternative" relationships which exist between the various meanings of homographic terms.

Homographic terms cannot be allowed in a retrieval system if selection of non-relevant information is to be avoided.

The references from a homographic term to the alternatives offered must therefore be of the "exclusive" type.

A see B or C leaves the indexer free to choose which term he will assign to replace term A.

In a number of thesauri the difficulty is overcome by adding more or less elaborate specifications to homographic terms: REPRODUCTION /BIOLOGY/ is unmistakably differentiated from REPRODUCTION /COPYING/[4].

One of the disadvantages of this method is that the inverted form of composite words has to be maintained in the alphabetic list if the alternative terms are to be found. CONDUCTIVITY /ELECTRIC/ and CONDUCTIVITY /THERMAL/ can be found by an indexer looking for CONDUCTIVITY, but ELECTRIC CONDUCTIVITY and THERMAL CONDUCTIVITY cannot.

Another solution consists in ignoring all but one of the meanings of a homographic term: FRONTS /METEOROLOGY/ rules out all other meanings of the word FRONT and other terms such as FOREHEAD, FRONTAGE, and BATTLE-LINE must be resorted to to express these concepts. In some thesauri the indications limiting the use of a number of terms to one of their meanings are extended in the form of lengthy scope notes.

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3. Structured vocabularies can be used in
a/ conventional information systems
b/ computer-assisted systems and
c/ fully automatic, interactive systems.

In conventional systems the document file can be arranged by thesaurus terms; there must be as many document copies in the file as thesaurus terms assigned to the document.

If the document collection is arranged by author name, format or in chronological order, a separate index file is prepared which contains, in the order given by the thesaurus /generally alphabetical/, one abstract or title card for each thesaurus term assigned to each document.

In a "dual-file" system, the abstract /or title/ cards are in numerical order /direct file/, while a second file contains one card for each thesaurus term with an indication of the document numbers to which the term was assigned /inverted file/.

The most popular dual-file system is the "peek-a-boo card" file.

Optional and alternative references can be noted on insert cards; compulsory references can be implemented by introducing additional file cards or punching additional peek-holes corresponding to the generic terms.

In computer-assisted and fully automatic systems, the thesaurus terms and structures as well as the files are stored on magnetic /or, exceptionally, photographic/ media.

The use of the computer's sort and print facilities for storing, sorting, updating, and printing successive versions of a thesaurus in various presentations is very popular. Computer-printed alphabetical lists, permuted term lists, inverted term lists, subject category lists, etc., can be found in many English-language thesauri.

The storage of the generic and semantic relationships between terms with a view to their application to stored indexes is a relatively new technique. This will be discussed in Chapter II.

The computer storage, processing and retrieval of direct and inverted files, again, is practised in all non-conventional systems, with widely varying results. These results, as shown in Chapter III, are largely conditioned by thesaurus structure and control.

II - Computer manipulation of term relationships

Preparing a retrieval file amounts to compiling the maximum number of relevant thesaurus terms as access points for retrieval by term coordination. The problem is one of identifying those thesaurus terms which are explicitly or implicitly contained in the tape-stored starting material. The starting material can be a corpus of titles, abstracts or full document text, or alternatively a set of manually assigned index terms.

In the first case, the computer is fed strings of non-standard, but generally correctly spelled words, and the "automatic indexing" routine will result in the selection of formally correct terms, the relevance of which cannot be guaranteed. The routine will involve splitting the text into single words for the identification of thesaurus uniterms, and into groups of two or more words for the identification of composite thesaurus terms. The identification of terms is complicated by the presence of non-standard word forms involving prefixes and suffixes, and by the occasional insertion of non-significant words between term components.

In the second case, the computer has to deal with generally standard, but often incorrectly spelled individual index terms, of guaranteed relevance, which can be directly matched with the thesaurus.

In both cases the computer can then be used to perform "generic posting", i.e. to carry out the information transfer suggested by compulsory references of the A add B type.

Note that B does not have to be an indexing term. In the Euratom system, for example, there are several hundred A add B references for the posting on to terms of a higher generic level, such as names of categories and disciplines, and cumulative designations which it would be nonsensical to use for the indexing of documents, but which are quite selective in the retrieval process.

The posting on to generic and cumulative terms does away with the need to include long arrays of alternative terms in query formulations.

Contrary to what might be expected, the expense occasioned by expanding the retrieval file through intensive generic posting is lower than the additional cost of manipulating strings of alternatives in the retrieval process.

Generic posting can be combined with a correction routine based on the A use B references. The correction routine amounts to replacing the incorrectly assigned term A by its preferred synonym B.

In the Euratom system this procedure was extended to encompass the correction of spelling errors introduced by indexers and keypunch operators. The errors detected by thesaurus matching and corrected manually can be fed into an "error dictionary" the format of which resembles that of the thesaurus. E use A means that every time the thesaurus term A is again misspelled E, it will be automatically corrected to A.

Among the errors occurring for the first time, those produced by addition or omission of one character, substitution of one character for another, or inversion of two adjacent characters, can be corrected by a separate computer programme, which changes, for example, ALCOOLS, ALCOHOLES, ANCOHOLS and ALOCHOLS into ALCOHOLS.

Every error corrected by this programme can in turn be fed into the "error dictionary" as an additional E use A reference.

The correction routine using term and error dictionaries can be developed, by inclusion of all possible word forms and spellings and a list of non-significant words, into a programme for automatic indexing. Experience has shown this approach to yield better performances than the method using word stems and truncated terms/6/.

However, the quality obtainable by automatic indexing is still largely inferior to that of indexing by specialists, and it can only become attractive if this shortcoming is balanced by lower cost. The major cost component being that for input rather than computer processing, automatic indexing will spread as the availability on tape of the starting material, i.e. the texts of documents and abstracts, comes into general use as a byproduct of publication. Optical character - recognition devices are not expected to become economic to the point where automatic indexing would be competitive.

The computer is also used to check the internal consistency of the thesaurus structure. In particular, every time a new term or a new reference is introduced, a complex automatic routine checks that the introduction does not lead to duplications, contradictions or continuous loops within the thesaurus or between the thesaurus and the error dictionary.

III - Effect of generic posting on thesaurus building

The number of A use B references in a thesaurus is generally kept as low as possible: It seems senseless to overburden a term list with terms that the indexer is not permitted to use. The majority of the terms are thus authorized for indexing and retrieval. This makes it easy for the indexer to find at least one term corresponding to the concept he has in mind, but the retriever has to browse through a great many RT, NT and BT references in order to assemble all the terms relevant to the query, i.e. all the terms that the indexer could have assigned to relevant items. The use of automatic generic posting radically alters the picture. First, the indexer can now limit himself to assigning the most specific terms corresponding to the concept to be indexed, since every relevant generic term will be automatically added. Indexing depth will decrease, as also the indexer's workload per item. On the other hand, the retriever will not have to bother about inclusion of alternate terms, since every term he may select for query formulation will bear the postings of all hierarchically subordinate terms.

In the Euratom System, where generic posting is being applied to a very large extent, the influence on retrieval performance has been the following:

Relevance ratio has significantly increased, since the indexers are free to follow their natural inclination, which is to put systematically more emphasis on specific indexing.

Recall ratio also increased, since it is no longer possible for the retriever to overlook relevant specific terms in the query formulation.

As both indexing and query formulation have become elementary operations, they take less time and have become less costly.

The Euratom Thesaurus was compiled as early as 1962 as a set of equivalent descriptors, following the example of ASTIA/8/.

A great many A use B references were then developed as a result of the indexing of more than 100,000 abstracts, and the indexers were systematically invited "to use term B in preference to term A whenever pertinent".

When, in 1964, Euratom's first computer was used to verify consistency of application of this rule, it became evident that the same inexpensive operation could be used for correcting errors /B use A/ and for generic posting /A add B/.Throughout the following years, A add B references from new specific terms /A/ to already existing descriptors /B/ were added to the thesaurus every time it was felt desirable. The distribution of the new references over the subject field was therefore not uniform. And the descriptor part of the thesaurus remained virtually unchanged, since many of the modifications which might have been considered desirable would have necessitated extensive re-indexing.

The situation is quite different in the field of metallurgy.

The European Community is now considering extending its information dissemination activities into the fields of metallurgy and, eventually, agriculture.

Preparatory work is being done including an inventory of the metallurgical literature and compilation of a metallurgical thesaurus.

This seems an excellent opportunity to apply the new methodology of thesaurus building.

A number of basic rules and a plan of work were agreed upon, and work on the thesaurus started in October 1968.

The following is an outline of our plan of work and the way we went about it.

Step 1: Define the subject field to be covered and make an inventory of existing thesauri and previous terminology studies.

Result: Three English-language thesauri compiled by ASM/9/, CSM/10/, and ISCOR/11/; a French thesaurus developed by CNRS/12/; a number of excellent encyclopedias; the Metals Handbook; and the subject indexes of the major abstract journals.

In view of the number and quality of these documents it was considered superfluous to compile a representative set of terms by statistical analysis of a text corpus.

Step 2: Eliminate duplicates from the term collection.

Result: From a total of 10,000 terms originating from three thesauri, 1,100 duplicates and 900 triplicates were deleted by alphabetical merging of the term lists, leaving a collection of 8,000 terms.

This step could have been combined with step 6; taken separately, it made steps 3 and 5 easier.

Step 3: Divide the subject field into coherent units containing 100 to 300 terms.

Result: Creation of 37 term subsets covering various aspects of metallurgy, including materials, properties and processes.

Step 4: In heavily loaded subsets, take special measures to standardize term selection and format.

Result: Creation of a rule for the generation of designations of inorganic compounds, ores, alloys and isotopes, by combination of element names with the words COMPOUNDS, ORES, ALLOYS, ISOTOPES, etc.

This rule may well burden the printed thesaurus, but not the user's memory.

Step 5: Display the terms corresponding to each unit in semantic charts, grouping conceptually related terms around their preferred synonyms.

Result: 900 preferred terms, defined by their semantic context, earmarked for descriptor status, with an average of 8 terms clustered around.

Step 6: Define the reference type for each term and record the references for computer storage.

Result: 3,800 descriptors, 1,000 A use B references, 50 A see B1 or B2 references, and several thousands of A add B references, on 80-column thesaurus form sheets.

Almost every term had to be verified in one or more handbooks and encyclopedias, decisions about homographic terms being the most time-consuming.

A number of terms were considered valueless in a thesaurus for use in a system based on term coordination, but they were retained, generally as A use B references, in order to achieve complete convertibility between the basic term lists /9/ /10/ /11/ and the new thesaurus.

Step 7: Computer storage, consistency check and printout.

Result: All the terms keypunched on 80-column cards, stored on magnetic tape, sorted alphabetically by first and by second terms, resulting in a printed thesaurus and an "inverted dictionary" with related terms grouped in synonym clusters.

Duplicate entries, contradictory entries and references loops are eliminated in the process.

Step 8: General revision and verification.

Result: The display charts were checked against the "inverted dictionary" and given their final presentation.

Term lists and display charts were critically examined by several experts; as a result of their comments a number of modifications were made.

The total effort involved in the compilation of the metallurgical thesaurus by two members of the staff and a small number of experts participating in the project was calculated at approximately 700 working hours, or four man/months.

Production of the two listings required only a few minutes of computer time using the IBM-360/40.

The above figures seem quite incredible when compared, for example, with the tremendous effort that went into the EJC[5] or DoD[4] Thesauri. Wall's figures[7],[13] represent a total of 70 man/months.

It is not surprising that, in the light of such an enormous expenditure of expert time /and money/ many studies were started on the possibilities of automatic generation of thesauri[14], which by the way, in turn, are costing a lot of computer time /and money/.

Now that the efficiency of automatic posting has been conclusively demonstrated, and with graphic display of semantic and hierarchic relationships making the compilation of generic references such an elementary operation, there is no doubt that more and more thesauri will be built, economically and efficiently, using these methods.

IV - Similarity factors

Generic posting takes care of the BT references in indexing and their NT counterparts in retrieval. The RT relators, however, representing a variety of ill-defined relationships, have escaped all attempts at computerizing so far. The documentalist in charge of indexing or query formulation will assess, from the display of semantic relationships in the terminology charts, which is the term most likely to represent a valuable alternative to a given concept because of its similarity or closeness to it. If this "semantic similarity" between two concepts or terms could be given a numerical value, the computer could be taught to store and use semantic similarity factors for a number of /or all/ term couples in a thesaurus.

The expression A/50/B might be used to mean that B is semantically similar to A to the extent of 50 percent, and a document tagged with term B might be expected to be half as relevant as a document tagged with term A.

Various methods have been thought up, aiming at making the computer determine statistically the value of the similarity factors on the basis of an indexed data base/15/. So far these experiments have not been conclusive.

We therefore consider making use of numbers assigned on the basis of expert judgment in the planned experiments involving similarity factors.

The basic experiment, of which a number of variations are under consideration, can be described as follows:

A question expressed by the customer as a combination of three aspects: A B C would normally be modified by the information officer to include a number of alternative terms /A2, B2, B3/ which he judges to be relevant in this particular case. The query thus becomes

/A + A2/ /B + B2 + B3/ C

If, however, the computer knows the similarity factors of all term couples involving A, B, and C, it can be told to select all terms having a similarity above a given cut-off value, say, 50 percent, and apply these as coefficients to the terms in the Boolean formula:

/A + 0,8 A2/ /B + 0,9 B2 + 0,6 B3/ C

A document tagged /A, B, C/ would be retrieved with a relevance probability /the product of the similarity factors involved/ of 100%, a document tagged /A2, B, C/ with a probability of 80%, a document indexed /A2, B2, C/ with a probability of 72%, and a document indexed /A, B3, C/ with a probability of 60%.

The computer, using the similarity factors, thus not only retrieves all the documents found by the human querist, but produces a ranking of the selected references according to their relevance probability. This relieves the system operator /or the final user/ of part of his burden and reduces the total cost of information retrieval.

Similarity factors are expected to play a rôle in the man-machine interactive information systems of the future.

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ANSWERS TO THE QUESTIONNAIRE ON THESAURUS PROBLEMS

Grete A.Schanche[x]

1a A thesaurus always comprises an alphabetically arranged, and may also contain a systematically arranged display of evaluated subject-oriented terms for indexing and retrieval purposes.

1b To call a given construction a "thesaurus" the following semantic and syntactic principles have to be fulfilled:

a/ The thesaurus has to be structured as to synonyms and quasi-synonyms, for instance by means of USE-references, SEE ALSO-references and USED FOR-references.

b/ The thesaurus must contain definitions of ambiguous terms, for instance by means of scope notes added to the term.

c/ The thesaurus must be accompanied by a set of rules giving instructions for:

use of the various grammatical forms of the words, like the use of nouns, adjectives, adjectives together with nouns, use of singular-plural form and so on,

use of accepted abbreviations /like "VTOL aircraft" for "vertical take off and landing aircraft"/,

use of symbols like - , //, greek letters, "per cent", "degrees centigrade" etc.,

use of trade names,

use of geographic names,

use of technical slang,

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combination of single terms in the thesaurus to complex terms by indexing and retrieval,

direct or inverted entry of complex concepts consisting of more than one word /like "fluidized bed" and "bed fluidized"/,

the candidate terms must be evaluated by a subject specialist as well as by a linguist.

The abovementioned are the basic principles of thesaurus construction. In addition to these there are other principles - the fulfillment of which give rewarding advantages to the thesaurus as a tool for indexing and retrieval:

A structurization of the thesaurus by means of a hierarchical listing of the terms or by a listing of broader term /BT/ - narrower term /NT/ relationships between the terms.

Such a structurization will cause secondary practical effects on the thesaurus by giving possibilities for preparing alphabetical lists for groups and subgroups within special fields. These may, besides serving their main purpose /indexing and retrieval tool/, be of value for studying the depth of indexing by means of word frequency studies. Such studies will in turn contribute to the development of the thesaurus towards an optimalization of usefulness. This means that the thesaurus contains a minimum number of rarely-used or too-often-used terms and a maximum number of relevant terms. It means further that the thesaurus should be supplied continuously with new evaluated terms and should be freed from obsolete terms by continuous deletion. This last point is in accordance with rapid technical development within the various special fields.

1c The elements or factors which influence the construction of a thesaurus are mentioned in 1b. Besides these factors, the aim of the thesaurus ought to be considered from case to case; whether it is going to serve a "polytechnical" /several branches/ or a more specialized field, whether it is going to serve one branch /company/ or one subject field and whether it is going to serve as a tool for both indexing and retrieval purposes. It is also important to evaluate the desired depth of indexing from case to case. This in turn will influence the thesaurus construction.

1d The degree of complexity and the number of information items /terms and various presentation forms of these/ have to be evaluated in connection with the aim of the thesaurus /answered in 1c/, in terms of what purposes are to be fulfilled. The economy of the thesaurus project in question is of course also an important factor, which will determine the degree of complexity.

2. When applied to the use of the thesaurus for coordinate indexing and retrieval, the existing definitions found in recent literature and used among documentalists /something like the definition given above under 1a/ should be sufficient. If the thesaurus concept is to cover broader uses, its definition has to submit to further analysis.

3. The role of the thesaurus is, according to the answer under 2, primarily for direct use as a most necessary tool in systems for indexing and retrieval. Secondarily it can be used as a vocabulary and dictionary aid for other purposes, for instance within scientific information as a whole, such as for authors editing reports, journal articles, for librarians in their choice of keywords for all kinds of scientific library material, etc.

4. The most rewarding way of collecting terms for a thesaurus is no doubt the compilation of evaluated terms from current indexing of new literature in the field in question, because this gives least "noise" with regard to artificially and seldom-used terms. It gives the current up-to-date language. In this work there are obvious advantages in using a computer when it comes to alphabetization of the word collection, for preparing alphabetized subject field lists, for construction of hierarchical connections, for production of inverted lists, permutated lists, for word frequency studies etc.

5. Of the topics mentioned in the questionnaire the first is in our opinion the most important, i.e. the classification of thesauri according to branches/subject. In fact both of these classifications can be of value.
   A company thesaurus usually ought to be a "branch" thesaurus, while a thesaurus for a scientific institution ought to be more subject-oriented.
6. A descriptor is a preferred keyword /term/ which in a semantic hierarchy has a place which may comprise a larger concept field than the one which is covered by one single keyword /term/.
7. The answer to this question is given under 1b.
8. The answer to this question is given under the last part of 1b.

RECOMMENDATIONS FOR THE BUILDING OF THESAURI IN SCANDINAVIAN LANGUAGES

Regler for bygging av thesauri pa nordiske sprak[x]

Extract in translation

Henning Spang-Hanssen[xx]

As to general points of view and as to order of presentation, the recommendations are in accordance with the Thesaurus, Rules and Conventions found as Appendix 1 to the Engineers Joint Council's Thesaurus of Engineering and Scientific Terms /New York 1967/.

Definitions:

By a document is meant the smallest bibliographic unit relevant to a system of registration and retrieval.

By a keyword is meant any word or composition of words appropriate in retrieval for the characterization of the content of a document.

By a descriptor is meant /1/ a preferred keyword that /2/ within a conceptual /semantic/ hierarchy takes up a position that /3/ may cover a conceptual field larger than the field covered by an individual keyword.

Purpose of a thesaurus:

A thesaurus serves the purpose of indicating the transfer of keywords /found in documents and in retrieval queries/ into descriptors accepted by the information store of a system of registration and retrieval.

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[x] by the Working Group for Thesaurus Construction, Scandinavian Council for Applied Research /NORDFORSK/.

[xx] Danmarks Tekniske Bibliotek, Copenhagen.

Contents of a thesaurus:
A thesaurus obligatorily comprises an alphabetized list. This list should include all keywords and all descriptors.

In addition, a thesaurus may comprise

1/ a permuted index /allowing to enter from inversions of normal word order, e.g. from absorption acoustic/;
2/ a subject category index, in which the descriptors are arranged according to categories /facets/;
3/ a hierarchical index in which descriptors having BT-or NT-references /cf. C-1/ are arranged hierarchically below the descriptor having the broadest meaning /covering the broadest conceptual field/;
4/ a list of notations /e.g. numeric codes/ for descriptors and for corresponding keywords.

Selection of descriptors: T-1
Descriptors are selected in accordance with their use in documents for indexing. In addition to all conceptually important words, forming the core of a thesaurus and being closely affiliated to professional terminology, descriptors may include names of persons, institutions, projects, locations, etc., and furthermore numbers, numerical intervals, and other kinds of identificatory symbols. Even bibliographical indications may act as descriptors.

The usefulness of a descriptor depends on

/a/ whether it is likely to occur in retrieval queries as an element conveying information;
/b/ whether it can be given a meaning distinguishable from the meanings of other descriptors;

Recomm. ... Scandinavian lang. -2

/c/ whether it can be given a definable meaning of general understandability.

Not useful as descriptors are words

/a/ never occurring in the relevant documents;
/b/ occurring in any document;

/c/ never occurring in retrieval queries;
/d/ having a vague and undefinable meaning;
/e/ having a meaning very close to that of some already-accepted descriptor.

For descriptors the **Singular of nouns** is used.[x] T-3

Instead of distinguishing in the way of English building and buildings, indicators of content should be used when necessary, e.g. building /process/ versus building /object/.

Indicators of content: T-5

In cases of doubt as to the meaning of a word to be accepted as a descriptor, the meaning should be pointed out by adding an indicator of content /a scope note/. The indicator is given in brackets, but forms part of the descriptor. The following cases deserve mention:

/1/ Cases of homonymy, e.g. English /mercury /metal/ and Mercury /planet/.
/2/ Cases where a noun is commonly used both of a process and of a product or a property /cf. T-3 above/.
/3/ A composition of words may have different meanings according to varying semantic relations between the components, and an indicator of content may thus be desirable, e.g. English water cooling /cooling with water/ versus water cooling /cooling of water/.
/4/ Trade marks and possibly other names may need an indication of the kind of article in question and/or of the fact that the name in question is a registered trade mark.

Complex descriptors /pre-coordinated descriptors/: T-11

Usually descriptors should be chosen in accordance with the terminology found in the relevant literature regardless of the number of words used in order to express the concept/the meaning/

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[x] The rules recommended here for Scandinavian languages thus deviate from the American rules.

in question. However, many potential descriptors seem to express concepts that are combinations of two or more other /potential/ descriptors. In such cases a decision must be made as to the inclusion of the specific, complex descriptor or the treatment as a combination of descriptors.

Specific, complex descriptors often facilitate the retrieval of specific information, but increasing the number of descriptors generally increases costs of indexing. The use of individual /not complex/ descriptors by indexing, and combining them during retrieval, permits a smaller thesaurus and of a more consistent terminology.

Recomm. .... Scandinavian languages -3

/a/ A specific, complex descriptor should be set up, if relevant and more general descriptors are not found in the thesaurus in question. In order to be relevant a combination of more general descriptors must comprise at least one descriptor that is a member of the same hierarchical class as the specific concept.

/b/ A specific, complex descriptor should be set up, if the specific concept is itself frequently met with, or if one /or both/ of the more general descriptors is very frequently met with.

In cases of doubt it is advisable to set up the specific, complex descriptor, at least temporarily, because in a working system it is easier to split up a complex descriptor than to combine existing descriptors into a new, complex descriptor.

Cross references: C-1

The connections between the descriptors and keywords within a thesaurus are indicated by 5 reference symbols having fixed meanings. In thesauri in the English language the most widespread symbols are /abbreviations of/ English words

USE UF /used for/ BT /broader term/ NT /narrower term/ RT /related term/.

In a thesaurus in a Scandinavian language it is not recommended to introduce abbreviations specific to this language, because confusion may arise. It is advisable /1/ either to accept the widespread English abbreviations, regarded as pure symbols, or /2/ to standardize - if possible - new, figurative symbols, e.g.

	>	<	A	V	//
for	USE	UF	BT	NT	RT

where A and V are to be read as letter substitutes for arrows pointing respectively upwards and downwards.

/More detailed definitions and instructions with examples for the 5 types of reference are given in the original as sections C-2 to C-9. These, and rules for alphabetizing /section A-1/ are omitted in this extract; from the numbering it will be seen that even sections T-2, T-4, T-6 to T-10 have been omitted. This translated extract tends to cover points of particular interest as to principles of thesaurus construction/.

PROBLEMS OF THESAURI

Jiří Toman[x]

The questionnaire does not contain questions which most probably could incite the participants to discussion - namely questions about the problems and the disadvantages of thesauri. As the host has invited us to add freely new points to the questionnaire, this paper tries to concentrate especially on both these aspects. In order to keep to the order of items as shown in the questionnaire, I shall deal with the individual points in the order of the questionnaire items.

ad 1. - 2.

One of the most important activities of librarians and information specialists is to index or classify the information materials, i.e. to express the topic of documents briefly by means of terms /called subject headings, uniterms, descriptors, key-words etc./. The terms representing the topics of documents can be arranged either alphabetically - according to the external form of the term - or systematically - according to their internal content. There is no third way of arranging them. These two ways of arranging the terms correspond to the two main trends of ordering systems, namely - alphabetic indexing systems /like subject headings, uniterms, thesauri of descriptors, key-words/ and systematic classification systems /both traditional and faceted/.

In English there unfortunately does not exist a broad term for the two narrow terms "indexing" and "classification". In Czech we use the broad term of "ordering systems" /similarly the Germans use the expression "Ordnungssysteme"/.

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[x] Czechoslovak Academy of Sciences, Prague.

In this paper the words "ordering systems" will be used to express both alphabetical and classification systems.

The thesaurus is an alphabetical system. It is necessary to stress this, because in some cases this expression is used nowadays to describe any special ordering system /as distinct from a universal classification system/, even if it is systematic. Unclear terminology would exclude discussion; therefore by "thesaurus" we should always understand an alphabetical system.

ad 3. Role

In conventional information systems it is immediately evident whether the catalogue is alphabetical or systematic, because the records in the files are arranged in one or the other way. In a mechanised system we cannot judge the character of the ordering system according to the arrangement of records. Most frequently their arrangement on magnetic tape is chronological.

Indexing and classification fulfil an important role - namely to arrange the records in storage

Every classification system uses systematic tables /systematical display of terms/ and an alphabetical index /alphabetical survey of terms/. Which of the alphabetical ordering systems, whether subject headings, uniterms or thesaurus, uses both of these aids? I somehow doubt that graphic maps of terms in a thesaurus correspond to the tables of a classification system. The lack of a systematic survey is a great disadvantage of many thesauri.

ad 4. Construction

Referring to my papers presented at the Elsinore conference in 1964 and at the Second Anglo-Czechoslovak Conference of Information Specialists in London in 1967 I shall repeat briefly the main ideas of the ordering principles and the theoretical considerations connected with it:

Every ordering system is governed by a combination of different ordering principles, whether alphabetical or systematic.

Nearly every one of these principles is in contrast with another principle:

Principle	Contrasting principle
alphabetical arrangement of terms	systematical arrangement of terms
uncontrolled dictionary	controlled dictionary
no hierarchy	hierarchy
open-ended system	closed system
precoordination	postcoordination
alphabetical display of terms	systematical display of terms /tables/

In addition to this there are two principles which have no antitheses - the principle of categories and the principle of expressing terms by notation. Both these principles are characteristic of the classification systems.

The chief idea expressed in the paper presented in London was, that there was a general tendency of these principles to merge and that the best solution seemed to be achieved by the synthesis of opposing principles:
Uniterms have no hierarchy, while UDC uses a strong hierarchy. Neither an excess nor a lack of hierarchy are good. A weak hierarchy therefore seems to be the best solution.

An uncontrolled vocabulary has great disadvantages, but similarly a controlled vocabulary - as we all feel - very often has the disadvantage of a Procrustean bed. In my opinion there will be a general tendency to add uncontrolled words to the records. I call them "explicative words" and they have no selective power /no search can be made on their basis/. We have introduced these words in our INDORES mechanized information system, and they serve us well. They are very important in the computerized systems where bibliography has replaced abstracts and where the strict use of a controlled vocabulary endangers the understanding of the content of a document.

Precoordination or postcoordination - that is the question. In judging this problem we must introduce into our considerations the question of whether the ordering system is used in a bound index, in a file or in a multidimensional medium like peek-a-boo cards, punched cards or a computer.

The conventional systems /bound indexes and files/ prefer precoordination, and multidimensional records prefer postcoordination. In spite of this I think that the best way of judging whether to precoordinate or postcoordinate is to ask: How will the user seek the information? If he is likely to request a document about the "circulation of journals", he must be given the possibility of searching under this precoordinated complex term. If he is likely to request also documents about the "circulation" of other materials, it is necessary to enter this document also under this postcoordinated term. And if he is not likely to demand the records about "journals" in general, we shall not classify it under this term at all. This way of solving the problem also means a synthesis of two principles /precoordination and postcoordination/.

Last but not least come the two antitheses - alphabetical and systematical arrangement of terms. Can we ever reconcile these two principles? The answer is affirmative: moreover this synthesis can be applied in two ways. In the first place by using both an alphabetical index of terms and a systematical display /tables/ in every ordering system.

However, within this, synthesis can be used even in the ordering system itself. We have done so in our faceted classification in the INDORES information system. This faceted classification consists of four categories. The classes in the categories are arranged alphabetically according to the capital letters /which were chosen mnemotechnically/. The terms in the classes are also expressed by mnemotechnical notation/in small letters/ and again arranged alphabetically. The system is a faceted classification with alphabetical arrangement of classes and terms.

All the considerations about ordering principles apply both to alphabetical systems and classifications

ad 5. Interbranch relations

Thesauri are special ordering systems; this is their great disadvantage in comparison with universal classification systems like D.C., U.D.C., Soviet Bibliographical-librarian Classification, Library of Congress classification etc. I doubt whether a univeral thesaurus could be built for a simple reason - when a thesaurus consists of more than 600 - 1,000 terms, both the indexer and the user lose the survey of the thematical content of the information system. A larger system needs unconditionally thematical tables /or at least maps/.

Although one is aware of all the drawbacks of different universal classifications, it is at least certain that they have not the great disadvantages of all special thesauri - the problem of marginal fields and the problem of auxiliary terms.

In every thesaurus the terms for marginal topics /chemistry, physics, mathematics/ must be introduced again and again /always in a different way/. There is no compatibility, although so many thesauri need these terms. Evaluating the situation in Europe now, one realizes that the only coordinating factor in the network of information centres - international and universal classification - is disappearing and the network is disintegrating. We are comming to an atomising stage - every branch and every nation /in the same branches/is constructing its own thesaurus. This is a problem of capital importance. On the other hand the introduction of computerized systems demands deep analysis in indexing - and a special ordering system /whether it be the thesaurus or a faceted classification/. How to solve this problem? It is certainly one of the greatest problems of this and other conferences on the problems of ordering systems.

My personal opinion is that we need a general classification system forming a roof above the special ordering systems /both thesauri and faceted classification in individual branches of human knowledge/. From this universal classification, which would not go into great detail /this would be the task of special systems/, we should use the terms for all marginal fields and all the auxiliary terms.

Who will work on the construction of this universal classification? In spite of the valuable work of the London Classification Research Group it is clear that it would take years to construct a new system of universal faceted classification. And reconstructing UDC for this purpose would also demand great efforts. It is obvious that besides this, it will be necessary to state general principles for the construction of special ordering systems.

BUILDING OF THE THESAURUS

David C. Weeks[x]

Two principal considerations in approaching the task of thesaurus building are: the domain which is to be represented and the sources from which concepts and terms are selected.

Whereas scientific and technical information systems have tended to develop independently in the past, we must recognize the inherent limitations of such a random pattern and seek means of overcoming those limitations. Influences helping to reverse this tendency stem from an awareness of the frequent overlap between domains or even disciplines and from a growing need for system-to-system communication.

The impact of these influences is apparent when we consider the elements that comprise the language of a thesaurus developed for a specific application in a discipline. Note, however, that the discipline is most probably a subdiscipline of some comprehensive discipline. This is largely a reflection of the trend towards systems serving narrower fields but treating them more intensively.

In these circumstances, a discipline-oriented thesaurus can be expected to contain four vocabularies, each essential to the literature of the domain and the retrieval interests of its users:

- the core concepts and terms of the discipline - the language essential to research and communication, describing the objects of concern and activities of the practitioner.
- the major discipline of which this domain forms a part - the scientific hierarchy illustrated by the domain of

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[x] George Washington University BSCP, Washington.

entomology which is a sub-set of invertebrate zoology - zoology-biology.

- other disciplines upon which the scientist or technician draws in the performance of his work. These may be cross-discipline domains such as chemistry/biology, physics/chemistry; or they may be used as tools of research such as statistics, logic, mathematics.
- the domains where this discipline may be applied - best illustrated by the application of information science to any scientific discipline.

Unless each of these elements is represented in sufficient detail, the thesaurus cannot be effectively employed as a tool for information control. It will fail to provide access to the varied topics contained in a corpus of documents and it will be unresponsive to the user's needs. As the interest in and need for system-to-system communications becomes more intense, the task of building a thesaurus becomes more complex. One way of reducing the difficulty and at the same time promoting compatibility is the development of standard, uniform methods for thesaurus building. This will encourage the symmetry and balance which are so essential to conversion from one system to another and for one system to complement another. Another means to the same end would be the development of standard components which could be incorporated into several thesauri, since the non-core elements are common to a number of domains.

Both possibilities require the combined efforts of specialists from various disciplines. The result of such projects would greatly assist in halting the random development of uncoordinated thesauri and of incompatible information systems.

Sources of Concepts and Terms

The term thesaurus is becoming a common name for any information system, indexing scheme or language. At the same time, the concept of a thesaurus is also frequently equated with a somewhat structured language in which broader, narrower and related terms are arrayed - not always according to some formula or rules that prescribe the level of terms. On the question of methods of compiling a thesaurus, there are at least three principles that must be considered in every instance, whatever techniques may later be applied to the actual task of compilation. These are: 1/ The source from which terms are to be selected; 2/ The purpose for which the thesaurus is intended; 3/ The approach to construction.

Two conventional methods have been used for the selection of terms. One method is the use of existing dictionaries and other lexical aids. This approach, more likely to be used for a discipline-oriented system, tends to produce a set of terms that is representative of accepted usage. Terms are likely to be relatively stable and to reflect a concensus of definition. Most disciplines have a number of technical dictionaries as well as encyclopedias, handbooks or similar basic resources from which terminology can be derived. A disadvantage of this method is that the vocabulary so assembled is somewhat "sterilized" and lacks the dynamic quality of current usage. Such a thesaurus may be difficult to relate to the language of literature or the patterns of recourse characteristic of potential users.

A second method - extraction of terms from a selected sample of documents - uses primary rather than secondary sources. Thesauri built from the language of literature are more current, but risk the need for more frequent amendment as the scope of literature is broadened in actual use. Terms of less stability will be more frequent and defining notes more necessary to specify the accepted meanings.Mission-oriented systems are the more likely applications for thesauri constructed from literature.

The purpose of the thesaurus is another issue that is essential to its construction. Those intended for application to the literature of a discipline are started with a different set of premises from thesauri being developed for an organization with a defined mission and functions. While a core of terms should be similar for a given discipline and a related mission, considerable difference is likely in the peripheral vocabulary. The two varieties are probably not interchangeable in application.

A third consideration in methods of compilation is the question of structure. In some instances, the structure is built first and terms are selected and assigned at the time of entry. Only in this way can a valid and workable thesaurus be constructed. Reversing this process and building a structure after the terms are collected creates an uneven and imbalanced structure not truly representative of the topical universe it is meant to define.

SOME PRAXIOSEMIOTIC PROBLEMS OF SCIENTIFIC INFORMATION[x]

Tadeusz Wójcik[xx]

Praxiosemiotics /the theory of optimal sign/, praxiolinguistics /the theory of optimal language/, the classification theory, the theory of the designation of the message /the entry characterizing the message/, the theory of automated information retrieval - all these branches of science play an important role in the development of scientific information and its theory.

In my report to the conference I present the principles of my work on formal aspects of the general classification theory and the theory of optimal language. I hope these considerations will in some way stimulate the development of the central problem of scientific information, i.e. the theory of retrieval languages.

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[x] This report is based on T.Wójcik: Prakseosemiotyka. Zarys teorii optymalnego znaku. /Praxiological Semiotics. An outline of a theory of the optimum sign/. Warszawa, 1969, PWN pp. 289.

[xx] Warsaw University, Warsaw.

1. General description of the processes of information and cognition

I have subdivided cognition into sensory, symptomatic and sign-message as successive stages of cognition, terminating with the exclusively human stage.

The main problem is that of message which is a tool for converting an uninformed man, animal or machine into an informed one. Both message and any of its component-parts, of various degrees of complexity, are signs.

A message may be in the form of a sentence, or larger text, photograph, portrait, map, graph, a chair tipped against a table in a cafe to indicate the place is taken, a doorbell, etc.

A message may act in diverse forms and especially as sound and light waves.

The postulates of the optimum message require that it be best adjusted to three sides, namely:

1. to the addressee of the message,

2. to its sender or creator,

3. to the reality communicated.

These postulates are compared with the corresponding postulates of the optimum tool in general, which in this case is a message.

The postulates of the optimum message are the following:

1. concerning addressee of the message,

    1. maximum access /in space and time/,

    2. maximum perception of the form of message,

   3. maximum clarity of message;

2. concerning the sender or creator of the message:
   1. maximum ease of learning the technology of making and sending the message,
   2. maximum tacility in making messages /both their content and form/ and sending them;

3. concerning the reality which a message reflects:
   1. unambiguity of the message,
   2. maximum correspondence between the message and the reality it reflects,
   3. optimum exactitude of the message.

To a large degree, though not completely, the message depends upon its components being optimum in order to achieve an optimum effect.

The code of message M is the classification of the set of components of message M. The postulates for the optimum code are: maximum reconstructability of the message from, the components of the code, maximum perception of the elements of the code, and maximum ease of learning its elements. Generally speaking, the optimum code of message M is that classification of a set of elements that is necessary and sufficient to make the message M optimum. This is the postulate of isomorphism between a set of elements of the reality described and a set of elements of a code that satisfy additional postulates with regard to the addressee and the sender of the message. A one-to-one correspondence is a particular example of isomorphism.

2. Classification codes

Classification codes are codes of classification messages /i.e. classification/[x].

One of them will be described here since it seems necessary for the understanding of the language code.

We make a table of classification assumptions to classify the set S with respect to features A, B,...N. The columns of the table will contain successive modifications of the features A, B,..., N /see Fig. 1/.

P - classificandum

	A	B	...	N	
	1	2	-	n	- criteria of classification/nonprecise/
0	A_0	B_0	...	N_0	- general forms of criteria of classification
1	A_1	B_1	...	N_1	- precised /detailed/ forms of criteria of classification /modification/
2	A_2	B_2	...	N_2	
...	...	...	...	...	
	W_A	W_B	...	W_N	- criteria of classification in precise form

Fig. 1. Table of Classification Assumptions /formal structure/

We may make different classification codes by transforming the components of the table. It is sufficient to show in addition the substance of the classification /notation/. This may be the codes of a "tree", a table, a group of words, letters or digits, etc.

I have enclosed, in brief, a method of making an ordered classification message in a positional digital notation which is a particular example of the naming notation. The symbols consist of digits which are detailed numbers of lines including precise forms of criteria /modifications/. The position of a digit in the classification symbol indicates the number of the column which includes the corresponding modifications. Hence the positional notation. The resulting ordered classification is called systematization.

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[x] The author has described the classification code in a much more complete form in his book Zarys teorii klasyfikacji. Zagadnienia formalne /Outline of the Theory of Classification. Formal Problems/, Państwowe Wydawnictwo Naukowe, 1965,184 pp.

The components of a message /parts of a classification/are placed in a permanent position in relation to one another so that the classification message will be ordered.

Directives for making an ordered classification of the set P with respect to A /in detail: A_o, $A_1, \ldots, A_x$/, B /in detail: B_o, B_1, ..., B_y/, ... N /in detail: N_o, N_1, ..., N_z/:

0. Make a table of classification assumptions of the set P with respect to the abovementioned detailed criteria /Fig. 1/.
1. Make an ordered Cartesian product of sets:

$$P \times /A_o, A_1, \ldots, A_x/ \times /B_o, B_1, \ldots, B_y/ \times \ldots /N_o, N_1, \ldots, N_n/$$

which are mentioned in the table of classification assumptions.

2. Eliminate the elements of the Cartesian product where the digit 0 precedes every other non-0 digit /e.g. 011, 201/.
3. Insert the resulting symbols into columns containing the same number of non-0 symbols,

in increasing order, and keep the order of the Cartesian product.

By following the above directives in order, we get the following results in the case limited to 2 modifications,each with three characteristic criteria:

Directive 0

P	A	B	C
0	0	0	0
1	1	1	1
2	2	2	2

Fig. 2. Table of Classification Assumptions /digital notation/

0 is the symbol for a classification criterium which is disregarded in a particular case.

Directives 1 and 2

P 000	P 100	P 200
P 001	P 101	P 201
	P 102	P 202
P 002		
P 010	P 110	P 210
P 011	P 111	P 211
	P 112	P 212
P 012		
P 020	P 120	P 220
P 021	P 121	P 221
P 022	P 122	P 222

Fig. 3. Cartesian Product. The eliminated elements are framed

A set P of cloths from a textile factory will serve as an example.

The set is classified /systematized/ according to the following criteria:A: substance of cloth /natural, synthetic/, B: thickness of cloth /thin $\leqslant$ 0,1 mm, thick $>$ 0,1 mm/, C: color of cloth /natural, dyed/.

Set table of ordered classification assumptions is the following:

Directive 3

Ordered classification — systematization				
One dimensional form	Two dimensional form Degrees of systematization			
	0	1	2	3
P 000	P 000			
P 100		P 100		
P 110			P 110	
P 111				P 111
P 112				P 112
P 120			P 120	
P 121				P 121
P 122				P 122
P 200		P 200		
P 210			P 210	
P 211				P 211
P 212				P 212
P 220			P 220	
P 221				P 221
P 222				P 222

Fig. 4. Systematization Message in a Positional-digital Notation

Cloth *P*	Criteria of classification		
	A	*B*	*C*
	Substance	Thickness	Color
0			
1	natural	thin	undyed
2	synthetic	thick	dyed

Fig. 5. Table of Classification Assumptions /example/

The classification components of the different cloths are as follows

P 000 = cloth /systematized set/,
P 100 = cloth of natural substance,
P 210 = thin cloth of synthetic substance,
P 121 = thick and undyed cloth of natural substance,
P 002 = dyed cloth.

The table classification is a particularly useful form of classification message. It has been widely applied to the classification-terminological standards in this country since the numerical notation is brief.

3. Language codes

Praxiological linguistics is a part of praxiological semiotics.The language is a classification of a set of sentential message elements. The optimum language contains exclusively the necessary and sufficient components for the optimum sentential message to be in as aesthetic a form as possible.

Two main tasks of praxiological linguistics are:

1. The task of cognition faciliates research on the basic language function on the basis of the simplest construction /praxiological model of language/. Such a construction would also facilitate a description of natural languages which may be hypothetically regarded as a deviation from the model.
2. The practical task of direct utility in:
   1. research on problems of machine translation,
   2. research on the creation of the optimum language.

The optimum language, while being primarily the language for scientific information, would enable direct communication of anybody with anybody else. Moreover, it would enable the formation of a better picture of the world, thus helping men to function much more efficiently intellectually. The problems of praxiological linguistics lie within the field of interest not only of logicians and linguists but also praxiologists, cyberneticists, psychologists and sociologists.To get to the root of the problem I have suggested an extensively developed group of grammatical terms. The formal structure of the optimum language is given priority in this elaboration which consists of syntactic and phono-graphical structures. Next come the general principles of building the semantic structure of notion groups, the content-structure. The last problem to solve is to establish a one-to-one correspondence between the formal structure and the content.

Particular consideration should be devoted to the syntactic structure of such sentential message components with increasing degrees of complexity, as an element of a word /roots, affixes, endings/, a word, phrase /a group of words like the subject and its modifiers/, a simple sentence, a compound sentence.

The classification algorithm of the optimum language is a set of instructions on how to make sentences or phrases at different degrees of complexity out of their lexical elements. The algorithm also concerns the making of phonetic structure of the language. Thus the algorithm is a formal instruction on how to form language expressions. The classification method also touches the problem of morphology - the problem of making correct notion groups. Although the problems of the formal side of the language can be easily solved, the content requires thorough research. Such research should concern the entire set of notion groups characteristic of different branches of science and reflect these notions in the forms of the optimum language at the formal, that is, syntactic and phonetic level. Thus the algorithm can only concern the formal aspect of the language.

The optimum language model consists of the following parts:

1. the classification algorithm
   1. of the syntactic structure,
   2. of the phonetic structure,

2. morphemes,
3. examples of some semantic solutions,
4. the main principles of a one-to-one correspondence between the form and content of the language.

The classification algorithm of the optimum language consists of a table of classification assumptions of the set of sentential message components, and an instruction how to make the ordered Cartesian product of the elements of the table.

Fig. 6 shows an outline of this algorithm.

C	Message components			
	A	*B*	...	*N*
0				
1				
...				
r				

Fig. 6. Table of Classification Assumption /message/ /for table C/:
⟨ A x B x ... N ⟩

We can get an algorithm of the syntactic or phonetic structures by substituting the variables accordingly.

The syntactic algorithm can be obtained in the form of one table of assumptions. However, it would be very large and hardly intelligible. Therefore, for the sake of convenience, we make four tables for their respective components of different degrees of complexity: one for the compound sentence; one for the simple sentence; and one for the component of a phrase or word, respectively.

C_s	Components of the sentence						
	Characterizer	Simple sentence	Conjunction	Simple sentence	Conjunction		Simple sentence
	A	*B*	*C*	*D*	*E*	—	*N*
0							
1							
...							
r							

Fig. 7. Table of Classification Assumptions /compound sentence/

Each of the four tables helps to obtain two results, namely:

1. A group of general structures of a definite kind - symbolized by 0-1.
2. A group of language expressions of a definite kind - substituting an appropriate expression for the variables.

The group contains 4 032 possible sentence structures.

An algorithm of the phonetic make-up of a syllable is based on a table of classification assumptions like the one below.

Ss	Characterizer	Description of components of a simple sentence													
		Subject – Object Phrase												Time-Space indicator	
		Nominator 1				Relator				Nominator					
		Quantificatum			Quantifier	Quantificatum			Quantifier	Quantificatum			Quantifier	Time	Space
		Indicator	Attributor Degree			Indicator	Attributor Degree			Indicator	Attributor Degree				
			1	2			1	2			1	2			
	0	1	2	3	4	1'	2'	3'	4'	1	2	3	4	5	6
	A	B	C	D	E	F	G	H	I	K	L	M	N	O	P
0															
1															
...															
r															

Fig.8. Table of Classification Assumptions /simple sentence/

Ph	Indicator Attributor Quantifier	Word Conjunction	Indicator Attributor Quantifier	Word Conjunction		Indicator Attributor Quantifier
	A	B	C	D	...	N
0						
1						
...						
r						

Fig.9. Table of Classification Assumptions /phrase component-extended/

A syllable consisting of two initial and two final consonants is regarded here as the most complex. There are the following types of syllables /here 0 stands for a vowel and 1, for a consonant/:

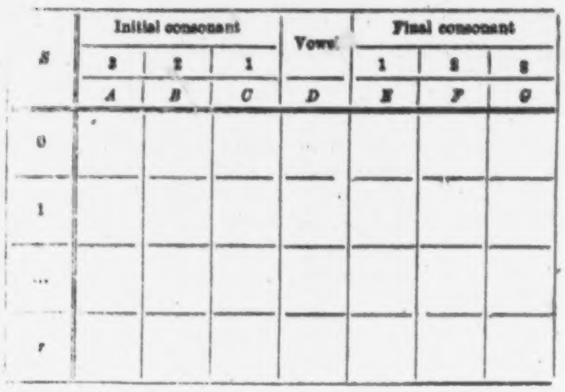
00-1-00	0
00-1-10	01
00-1-11	011
01-1-00	10
01-1-10	101
01-1-11	1011
11-1-00	110
11-1-10	1101
11-1-11	11011

W	Word Components							
	Semantic precisioner Sem I			Root (Rad)	Semantic precisioner Sem F			Syntactic precisioner (Synt)
	Sem I_1	...	Sem I_k		Sem F_1	...	Sem F_k	
	A	...	*E*	*F*	*G*	...	*M*	*N*
0								
1								
...								
r								

Fig.10. Table of Classification Assumptions /word/

Phrases					
0	1	2	3	4	5
1	1111	1111	1111	1	1
2	1101	1101	1101	0	0
3	1001	1001	1001		
4	1110	1110	1110		
	1100	1100	1100		
	1000	1000	1000		
			0000		

Fig.11.Group of structures of Simple Sentences



S	Initial consonant			Vowel	Final consonant		
	3	2	1		1	2	3
	A	B	C	D	E	F	G
0							
1							
...							
r							

Fig. 12. Syllable

Such is the thorough description of the classification algorithm of the formal structure of the optimum language: the syntactic and the phonetic structure.

The grammatical morphemes are the following sets:

1. characterizer e.g.: it's so that, it's not so that, let it be so, is it so?
2. sentence conjuction e.g.; or, and if... then, if only,
3. quantifier e.g.: 0,1..., certain, every, few, many,
4. wordconjunction e.g.: or, and, nor, together with,
5. syntactic precisioner e.g.: object, feature, relation, manner, place, time,
6. semantic precisioner e.g.: -ness, -ry, -ism, -logy, etc.

I have given some specimens of lexical morphemes in this account.
Namely: the table of syntactic precisioners and some semantic precisioners /relator precisioners, basic and auxiliary/, precisioners of gradation, relator precisioners of attributor /some specimens/.

Besides, I have given the table of personal pronouns and a few quantifiers /numerals/.

Syntactic precisioner or syntactic type of word			Sentence function of word					
			Designating Designator		Attributing Attributor Quantifier		Function Conjunction	
							Word	Sentence
Semantic denomination scope of word		Object	Subject or predicator Nominal	Object marker -o	Attributor	Object -a	—*	-as
	Feature	Described		Feature marker of an object -i		Feature -u		
		Describing a state or relations; a kind of existence	Predicate Relator	Feature marker of type of existence -*	Adverbial	Attributor of type of existence -e		

* Introduce some pronounceable sound variables. Some precisioners are null (for a few lexical groups). The next examples are derived from Latin).

Fig. 13. Syntactic Precisioner

Semantic precisioner of relator (basic) Type of existence				Symbol	
				Number of phrases	
				1	2
1	General (to exist)			*-als*	*-als*
2	Functional existence	General (tc function)		*-al*	*-al-*
3		Independent (o change into)		*-ar-*	
4		Dependent	active (to change into)		*-an-*
5			passive (to be changed into)		*-at-*
6	Extra-functional (to be a...)			*-as-*	*-as-*

Fig. 14. Semantic Precisioner of Relator /basic/

Examples (derivatives of „term")

termi	— temperature	*buterman*	— to cool
butermi	— cold	*puterman*	— to freeze
putermi	— frost	*putermajno*	— freezer
potermi	— cool	*baterman*	— to air-condition
batermi	— tepid	*bitermajno*	— radiator
bitermi	— hot	*putermato*	— frozen substance
pitermi	— heat	*putermani*	— freezing process
petermi	— warmth	etc.	

Absolute gradator			Comparative gradator		
Small	generally	*bu*	*blu*	<	Smaller than
	very small	*pu*	*plu*	the smallest	
	quite small	*po*	*plo*	<	
	Medium	*be*	*ble*	Equal	
Large	generally	*bi*	*bli*	>	Larger than
	quite large	*pe*	*ple*	>	
	very large	*pi*	*pli*	the largest	

Fig. 15. Semantic Precisioner of Feature Gradation /gradator/

Some examples of the use of the relational precisioner of an attributor:

1. how existing, functioning? /null precisioner/
   domo ligna - wooden house, scriban bone - to write correctly
2. related to /whom/? re-
   re-Petra frato - Peter's brother
3. Whose property? di-
   di-Petra domo - Peter's house
4. making, doing what? la-
   la-libra scribano - /a man/-writing a book
5. made, done by whom? par-
   -par-Petra libro - a book written by Peter.
6. coming from where? de-
   de-Africa frukto - an African fruit /from Africa/
7. destined /suitable for/? pur-
   pur-homela vesto - women's wear /for women/

So much for the syntactic structure of language. One can especially extend other semantic precisioners. The phonetic structure of language requires experimental research by phoneticians and psychologists.

This means choosing the optimum sounds and the syllable make-up and then the prosodic features of the language.

The application of the optimal language to the needs of scientific information opens broad perspectives for improving the work of information systems.

1. Existor and syntactic derivatives

	Initial semantic precisioner (Sem I)									Rad	Final semantic precisioner (Sem F)											Syntactic Precisioner (Synt)		
	Location of existence		Phase of existence			Degree of feature (alternatively)					Reality of existence		Speaker's attitude and period of existence				Principal type of existence						
—	8		7					6	5	4	3		2				1				0		
0		—			—			—	—	-f-	real	—				—				—	Nominator	existence	—
1	position?	—		planning	hu		generally	bu	blu		unreal	-al	Declaration		timeless	-a-			generally	-ls-		feature	-i
2	whence?	do	realization	beginning	ho	small	very	pu	plu	…				time	future	-u-	functional		general	-l-		object	-e
3	whither?	da		continuing -	ha		quite	po	plo						present	-o-			independent	-r-	Attributor	existence	-e
4	which way?	de		repeating	he	medium		pa	bla						past	-i-		dependent	active	-n-		feature	-u
5	how located?	di		finishing	hi	large	generally	bi	bli				Command			-e-			passive	-t-		object	-a
6				terminating	hy		quite	pe	ple				Question			-y-	extrafunctional			-s-			
7							very	pi	pli														

2. Another word

8	…	Sem I_2	Sem I_1	Rad		Sem F_2	Sem F_1	Synt

Fig. 16. Table of Word Classification Assumptions

General subject/object (personal pronoun)					Generally	Particularly		
						Gender		Neuter
						masculine	feminine	
„Person"	0	someone something	Plural/Singular	generally	*lo*	*ilo*	*elo*	*olo*
				singular	*pralo*	*prilo*	*prelo*	*prolo*
				plural	*zalo*	*zilo*	*zelo*	*zolo*
	1	I we		generally	*mo*	*imo*	*emo*	
				singular	*pramo*	*primo*	*premo*	
				p lural	*zamo*	*zimo*	*zemo*	
	2	you (sg.) you (pl.)		generally	*vo*	*ivo*	*evo*	
				singular	*pravo*	*privo*	*prevo*	
				plural	*zavo*	*zivo*	*zevo*	
	3	he(she), it, they		generally	*ro*	*iro*	*ero*	*oro*
				singular	*praro*	*priro*	*prero*	*proro*
				plural	*zaro*	*ziro*	*zero*	*zoro*

pra = one; *za* = more than one

Fig. 17. Personal Pronoun

Terms of existence for root <ved>					Syntactic type					
					Nominator			Attributor of		
					Existor	Feature marker	Object marker	Existence	Feature marker	Object marker
					—	-*i*	-*o*	-*e*	-*u*	-*a*
Existence	generally			— (*ais*)		informative cognition process	element of informatively cognitive process		No English counterparts	
	functional	general		*ai*	to function informatively	infirmative functioning		informatively		informative
		independent		*er*	to get to know	cognition process	the one who gets to know	cognitively		cognitive
		dependent	active	*en*	to get informed	informing process	the one who informs	informingly		informing
			passive	*ei*	to be informed	the state of being informed	the one who is informed	?		knowing
	extra functionally			*es*	to know	knowledge	the one who knows	with knowledge		

Fig. 18. Family of words /example/

ON A DEFINITION OF A THESAURUS SYSTEM AND THESAURUS STRUCTURES

Irena Bellert and Olgierd A. Wojtasiewicz[x]

In the papers submitted for the International Conference on General Principles of Thesauri Building, held in Warsaw in March 1970, and in the discussions which took place during the Conference, the terms "system of thesaurus", "structure of thesaurus" have been used repeatedly in several contexts without being precisely defined - moreover, in different senses of these terms. We believe that a formal definition of the system of thesaurus that would account for the relations involved would make it possible not only to use these terms consistently, but also would be helpful in constructing thesauri which pertain to selected areas of science or technology in accordance to the same well defined scheme, independently of the language in which the given thesaurus is described. A comparison of thesauri in two different languages could thus be arrived at more easily and multilanguage thesauri could more conveniently be constructed.

The present proposal can be treated as a comment and an outline of a formal description of the ideas contained in the UNESCO Guidelines for the Establishment and Development of Monolingual Scientific and Technical Thesauri for Information Retrieval, a paper submitted for the International Warsaw Conference on General Principles of Thesauri Building. It goes without saying that for a more specific formulation of the relations discussed below, it would be necessary to elaborate on this topic in connection with a given specific area of science or technology.

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Any system can be defined as an ordered sequence

$$\langle A, R_1,\dots,R_n\rangle$$

where A is a set and R_i /for $1 < i < n$/ is a relation defined on A.

A thesaurus can be defined as a specific system:

$$\langle T, R_1,\dots,R_n\rangle \qquad /1/$$

where T is a finite set of terms /nouns and noun phrases of a natural language/, and the relations $R_1,\dots,R_n$ are one- or two - place relations defined on T. Certain relations will be characteristic of a specific domain of science or technology, others will be characteristic of any domain for which a thesaurus may be constructed. Among the latter relations we may mention a linear order relation corresponding to the alphabetical order; partial order relations corresponding to concepts such as "term broader than", "term generic to" /and their respective converses: "term narrower than", "term specific to"/, "part of whole" etc. equivalence relation, such as synonimity relation between terms; other relations corresponding to concepts such as "used for", "belongs to the domain of", "thing-property", etc.

It is worth noting that every relation determines a graph, which would correspond precisely to what is referred to as "graphical display" in the description of thesauri. The term "structure" as used in connection with thesauri can thus be identified with the structures of the graphs determined by the corresponding relations. In this connection the terms "system" and "structure" as used in the description of thesauri would be interrelated and precisely defined. For we have a set of structures given by each thesaurus described as an ordered system consisting of a finite set of terms and a sequence of relations.

Let us now present some examples of relations which can be defined for any thesaurus, and give some additional comments.

The synonimity relation R_{syn} is an equivalence relation defined on T, for it is:

/a/ reflexive $R_{syn}\ /x,x/$
/2/ /b/ symmetric $R_{syn}\ /x,y/ \Rightarrow R_{syn}\ /y,x/$
/c/ transitive: $R_{syn}\ /x,y/ \wedge R_{syn}\ /y,z/ \Rightarrow R_{syn}\ /x,z/$

R_{syn} - being an equivalence relation - forms a partition on the set T, that is, it divides the set T into non-empty, disjoint subsets /equivalence classes/. We may then choose a representative element x_0 from each subset that contains more than one element, and the term chosen as a representative, will then be used in the description of other relations, all the other elements will appear only in the relation of alphabetical order, and will not be used anywhere else.

The set T will comprise all the possible terms, descriptors and non-descriptors. The set T can thus conceived of as

/3/ $$T = D \cup N$$

to be read thus: the set T of terms is the union /logical sum/ of a set D of descriptors and a set N of non-descriptors;

D and N are finite, non-empty disjoint sets:

$D \cap N = \emptyset$

The following relations can also be defined

/4/ $$P\ /a,b/$$

/5/ $$B\ /a,b/$$

/6/ $$R\ /a,b/$$

P/a,b/ is the preference relation, and may be interpreted thus: a is to be preferred to b as a descriptor. This relation is obviously irreflexive, asymmetric, and intransitive. If a term is once rejected as unsuitable to be a descriptor, then it cannot on any other occasion be given preference to any other term, because if it were given preference, then it would have to be included in the list of descriptors in spite of being previously disqualified as a descriptor.

B/a,b/ is the relation holding between a broader and a narrower term: *a* is a broader term than *b*. This relation is irreflexive, asymmetric, and transitive, and as such it is an ordering relation. The relation holding between a narrower and a broader term, N/a,b/, also listed in the Guidelines, can trivially be defined as the converse of the former:

$$/7/ \qquad N/a,b/ \Longleftrightarrow \breve{B}/a,b/ \Longleftrightarrow B/b,a/.$$

R/a,b/ is the affinity relation, and is reflexive and asymmetric, but not transitive: although transitivity may be observed in certain cases, it may not be assumed to be a rule. This can be explained by the following example: *steam* and *steam engine* are related terms, and so are *steam engine* and *combustion engine*, but steam and *combustion engine* presumably are not related.

The following implications are assumed:

$$P/a,b/ \Rightarrow //a \in D/ \wedge /b \in N//,$$
$$/8/ \qquad P/a,b/ \Rightarrow R/a,b/,$$
$$B/a,b/ \Rightarrow R/a,b/.$$

The following relation can be defined by the well-known procedure:

$$/9/ \qquad B'/a,b/ = B/a,b/ \wedge \neg \bigvee_{c} /B/a,c/ \wedge B/c,b//.$$

This is to be read thus: *a* is the next broader term to *b* /*a* is broader than *b* and there is no term *c* such that it stands between *a* and *b* in the hierarchy of broadness/.

In the definitions below it is assumed that *a* and *b* are in D, and hence this fact is not marked in the formulae.

$$/10/ \qquad A/a/ = \left\{ b: R/a,b/ \right\} .$$

This is the affinity class of *a* .

$$/11/ \qquad F/a/ = \left\{ a \right\} \cup \left\{ b: B/a,b/ \right\} .$$

The field of a: a and all those terms to which a is broader. In the definions the one-element set $\{a\}$ must be included since B is not reflexive, B/a,a/ accordingly does not hold, and thus a would not be in its own field. This does not apply to /8/ as R is reflexive.

$$/12/ \qquad H/a/ = \{a\} \cup b:\{/B/a,b/ \vee B/b,a//\} \ .$$

This is the hierarchy class of a, which, as compared with F/9a/includes not only those terms which are narrower than a, but also those which are broader than it.

Usually in a hierarchy class limits must be set beyond which certain terms are not included because of being either too general or too specific. This can be defined as follows:

/13/ a = minimally narrow term/s/ in H/a/ $\Longleftrightarrow$

$$\bigvee_{\Longleftrightarrow b \in H/a/} /B'/a,b/ \wedge /a \in D/ \wedge \neg /b \in D// ,$$

/14/ a = maximally broad term/s/ in H/a/ $\Longleftrightarrow$

$$\bigvee_{\Longleftrightarrow b \in H/a/} /B'/b,a/ \wedge /a \in D/ \wedge \neg /b \in D// .$$

It is to be noted that the preference relation does not ensure the inclusion in D of all those terms which it may be desirable to have as descriptors. This is so because this relation provides for the inclusion in D of those terms which are preferred to some other terms. It may happen, however, that a term is to be included even though its inclusion does not imply the exclusion from D of any term. If, for instance, one makes a thesaurus of chemical terms, he will include as descriptors the names of all chemical elements. Hence, if oxygen is included, this fact does not bar any other term from inclusion in D under the preference relation. This is why it is recommended that an inclusion operation be introduced, to be defined thus:

$$/15/ \qquad I/a/ \Rightarrow /a \in D/ \ .$$

Obviously,

/16/ $$P/a,b/ \Longrightarrow I/a/ ,$$

but not conversely.

The Guidelines mention the whole-part relation as a case of the relation holding between a broader and a narrower term. It is to be noted, however, that B holds between terms, and the whole-part relation holds between designata of terms /that relation can also hold between terms in the sense that *combustion* is part of *combustion engine*, but this obviously is not what the authors of the Guidelines mean/. If this relation is to be retained, the following improvement is suggested. A relation M holding between terms is introduced and is tentatively defined thus:

/17/ M/a,b/ $\Longleftrightarrow$ there exist x and y such that x and y are objects, and x is part of y, and a and b are names of x and y, respectively.

The concepts defined or introduced above can be used in a further extension of the formal description of the system under consideration. E.g.,

/18/ $$F/a/ \subset H/a/ ,$$

/19/ The fields of *a* and *b* overlap $\Longleftrightarrow F/a/ \cap F/b/ \neq \emptyset$.

As the main goal of the construction of thesauri is their use in retrieval systems, it would be desirable to describe a thesaurus system as a component of a retrieval language. An analogy suggests itself with a description of a natural language system. The search for a recursive system of rules for generating all and only sentences of a natural language has been in the centre of attempts made by a number of recent linguistic projects. It has appeared that the problems of grammar and lexicon are deeply interconnected, and no adequate description of lexical entries can be achieved without syntactical information. It seems that, analogically, there is an interconnection between a thesaurus system and a retrieval language. The retrieval language to be used for a thesaurus should be constructed in close relationship with the structures determined by the relations defined on the set of terms T, as discussed above. It is necessary to specify what sort of questions can be asked in a retrieval language, and this cannot be done otherwise than by relating them to the thesaurus system which has to be precisely defined for that purpose. It may be worth mentioning here that those who work on constructing thesauri and retrieval systems are in a better position than linguists, for they can establish normative, rather than descriptive rules/they can get rid of synonyms, homonyms or vague terms/.

In conclusion, we wish to emphasize that the problem of a formal description of thesauri has been only touched upon inconclusively, but the matter seems worth elaborating on, and our goal was to draw the reader's attention to such a possibility.

MINUTES OF THE CONFERENCE

Monday, 23rd March 1970. Afternoon Session. Chairman: J. Toman

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POINT 1 OF THE QUESTIONNAIRE: DEFINITION OF A THESAURUS

1.1 What is meant by a thesaurus?

Mr. T. M. Aitchison: "A thesaurus is an alphabetical listing of concepts /i.e. descriptors/ which provides structural and relational information about the concepts".

Mr. Jansen: For purposes of information storage and retrieval a thesaurus is an orderly compilation of concepts

- represented by as many synonymous terms as possible in one or more languages,
- in which homonymous terms are specially marked,
- in which a descriptor univocally represents a concept, and
- in which semantic relationships between concepts are registered.

Underlying definitions:

1/ Definition of Concept:

Mental idea of material or immaterial object based on common characteristics which are usually formed by abstraction and found identical.

2/ Definition of Term:

Name given to a concept and consisting of one or more words.

3/ Definition of Descriptor:

Univocal representative of a concept in a documentation system. The descriptor can be a fixed term /"preferred term"/ or any other stipulated designation.

Mr. Leski: "A thesaurus may be defined as follows: An open system covering a determined full thematic range containing an orderly multitude of terms, some of which are admitted as descriptors, showing the relations between these terms and their mutual dependence".

Mr. Rolling: "A thesaurus can be defined as a structured vocabulary for use in information storage and retrieval systems".

Mr. Wysocki cited the definition from the UNESCO Guidelines: "By the word thesaurus is meant a comprehensive and structured vocabulary of interrelated terms some of which are used in the indexing and retrieval of a collection of documentary material pertaining to a specific domain or domains of science and technology".

Mr. Toman pointed out that a definition of an object must distinguish it from other similar objects but unfortunately in most of the cited definitions the words "classification", "uniterms" or "subject headings" can be inserted instead of the expression "thesaurus", and still the definition would keep its sense.

The session decided to postpone this question to Wednesday or Thursday when other problems of thesauri would be discussed.

Mr. Toman proposed to build the definition /or better, explanation/ by expressing first the purpose of the thesaurus and then by describing its possible characteristics: "A thesaurus is a system of controlled terms used for characterizing the content of documents in a storage and/or retrieval system. Conventional thesauri use alphabetical listing for displaying synonyms, hierarchy, and other relations, whereas thesauri with graphic maps stress the importance of the systematic display of terms. Thesauri are further characterized by their dynamics, by a weak hierarchy, by preferring post-coordination to pre-coordination. In contrast with classification systems they show related terms other than synonyms, broader and narrower terms, but do not use notation or categories".

Mr. Varga considered some requirements regarding the terms of a thesaurus, pointing out that they must

- be based on a natural language,
- be unambiguous,
- constitute a decentralized collection.

As to relations within a thesaurus, they must
- express only objective, not artificial connections between terms,
- show many aspects of a connection
- be clearly distinguished
- be reciprocal

1.2 Structural elements

The participants in the session indicated several elements characteristic of thesauri:
- dynamics of the thesauri /a better word than "open-endedness"/;
- display of hierarchical, synonym and associative relations;
- display of relations: term to term, concept to concept, concept to term.

1.3 Factors influencing the organization of a thesaurus:

Messrs. Lloyd, Gravesteijn, Leski, Molnár, Mojžišek, and Maixner stated these factors:
- branch of science or technology
- thematical range and overlapping
- assumed degree of fineness
- users´ requirements
- grammatical rules
- structure of the file
- methodology of the system
- clearness or vagueness of the terminology of the branch
- language /Hungarian or German/
- nature of the medium of the record /whether a bound index, a card file or a computer/.

Mr Rolling completed this list by citing his formula for the size of a thesaurus:

$$T = a\,k\,\sqrt[n]{\frac{V}{R\,k}}$$

T - size of thesaurus
a - indexing depth
k - redundancy factor /number of synonyms/
n - retrieval strategy /numbers of terms according to the strategy/
V - size of document collection
R - response /number of references expected by the type of user/

With regard to the structure of thesauri Mr. Varga stated that thesauri must be:

- compatible
- easily broadened
- easily corrected

Tuesday 24th March, Morning Session. Chairman: Mr. L.Rolling

ITEM 1 ON AGENDA: THE ROLE OF THESAURI

The main use of a thesaurus is for terminology control in indexing and retrieval.

Agreement was reached on the following:

The role of a thesaurus is to ensure that indexing and retrieval of documents can be effected with maximum efficiency /precision and completeness/.

In addition, the existence of a thesaurus covering a subject field tends to stabilize the terminology of this field.

ITEM 2b ON AGENDA: THE DEFINITION OF A DESCRIPTOR

The Chairman analysed the definitions proposed by Messrs. Leski, Jansen, Spang-Hanssen and Molnár, and the definition contained in the UNESCO Draft Guidelines. They agreed that:

- a descriptor is a formalized, standardized, or controlled term;
- a descriptor is to represent one /or a combination of/ concepts in an unambiguous, or univocal way;
- and that descriptors can consist of symbols.

Mr. Jansen thought that notations must also be considered as descriptors; Mr. Rolling was of the opinion that notations such as classification codes or current numbers assigned to descriptors for further processing cannot be considered as descriptors.

Messrs. Rosenbaum and Poletyło wished to limit the use of descriptors to systems based on concept coordination; subject headings should not be considered as descriptors.

The assembly appeared to agree on the following:

A descriptor is an authorized and formalized term or symbol in a thesaurus used unambiguously to represent the concepts of documents and queries in information systems based on concept coordination.

ITEM 2c ON AGENDA: THE DEFINITION AND NAME OF FORBIDDEN TERMS

The assembly preferred the name NON-DESCRIPTOR to the proposed name ASCRIPTOR.

By definition, any thesaurus term or symbol not considered as a descriptor is a non-descriptor.

ITEM 2d ON AGENDA: REQUIREMENTS TO BE FULFILLED BY A DESCRIPTOR

It was agreed that a descriptor must unambiguously characterize the concept/s/ that it represents, and that its spelling should be subject to a number of rules.

Agreement was also reached on the requirement that a descriptor must have a "reasonable" frequency of assignment and possess a certain combinatory power. A "reasonable" frequency could be defined, according to Mr. Molnár, as a function of average frequency of assignment.

Tuesday,24th March 1970. Afternoon Session. Chairman: J.Lloyd

The meeting reconvened at 3.oo p.m. to continue its consideration of point 2 of the revised agenda: "What should be demanded in order to accept a term as a descriptor". The question of grammatical form was placed before the group and Mr. Wysocki read from page 5 of the UNESCO Guidelines onward. Mr. Spang-Hanssen observed that the proposed UNESCO rules concerning "number", "noun form", etc. were not applicable to many inflected European languages.

Mr. Wysocki pointed out that the Guidelines were written in English, for English, as stated in the document.

General opinion was that since grammatical usage varies from language to language, it was better for each thesaurus to establish its rules, state what they were in a preface, and stay absolutely consistent with them throughout.

The meeting then moved to point 2e of the revised agenda: "The terminology of cross-references".

Mr. Varga questioned the Guidelines approach to cross-references between various thesauri.

Mr. Wysocki explained that the purpose of the Guidelines was not directed to the construction of any one thesaurus.

Mr. Varga then spoke on relations within a thesaurus and the significance of hierarchical and non-hierarchical concepts both within and beyond a thesaurus.

Mr. Spang-Hanssen asked if we were discussing "roles" and if so, did they belong in a thesaurus?

The Chairman directed the discussion back to "preferential, hierarchical, and affinitive" as proposed in the Guidelines.

Mr. Rolling suggested that concepts might be linked in an A + B relationship by "generic posting" as discussed in his paper. He preferred this procedure to posing a Boolean query in retrieval.

Mr. Toman suggested that as terms can be members of a plurality of hierarchical chains, all relationships should be shown by tables or a thematic display.

Mr. Jansen agreed and offered a citation from E.Wüster: "Die Struktur der sprachlichen Begriffswelt und ihre Darstellung in Wörterbüchen".

The assembly agreed to accept section X of the UNESCO Guidelines.

It was agreed to postpone point 3 of the revised agenda until after formulation of a definition, and discussion was continued on point 4 a: "The methods of building thesauri".

Mr. Toman proposed two thesauri building methods: from the bottom and from the top. The first would involve collecting terms at random from experts, other thesauri, glossaries, etc. - then deciding on hierarchy, synonyms and homonyms. "From the top" implied selecting large classes, subdividing them more specifically, and continuing in this fashion.

Mr. Mojžíšek briefly explained the statistical approach being developed at his institute in Prague and referred the group to his printed report on the subject.

Mr. Leski explained, with schematic diagrams, the system being used in Warsaw, which combines a theoretical and practical approach.

Mr. Schiff explained the KWIC indexing being used at the Central Technical Library in Budapest in order to provide subject specialists with information as quickly as possible. Experts then underscore the relevant words from the KWIC for each document and return the information to the library. They are thus building up a file of subjectively-approved descriptors that will be used in the future for thesauri building.

Discussion turned to "overlapping fields", and Mr. Leski said that a thesaurus cannot be narrower than a discipline. He graphically displayed the problem of discipline overlap between chemistry, physics, and biology. He stressed that hierarchies may change within the area of overlap.

Mr. Mojžišek stated that his statistical method would solve overlap.

Mr. Gravesteijn discussed the difficulty of resolving overlap problems with disparate disciplines, or even sub-disciplines such as exist in geology.

Mr. Spang-Hanssen. Concerning singular and plural, cf. UNESCO Guidelines, VIIc:

"The use of singular versus plural form to denote different concepts /cf. the example WOOD versus WOODS in the UNESCO Guidelines/ is comparable to the use of qualifiers for homonyms /cf. the example BEAMS /ELECTROMAGNETIC/ versus BEAMS /STRUCTURAL/, and since there are languages in which a plural ending is not always present /e.g. Swedish/, the use of qualifiers seems recommendable as a universal tool".

"In cases where only the singular or the plural form of a given word is included in a thesaurus, the question is reduced to a pure matter of expression, and it seems recommendable that either singular or plural can be used consistently".

Concerning the reference systems suggested by Mr. Varga and Mr. Jansen:

"The more elaborate systems of relationships, including aspects that have been suggested by Mr. Varga and Mr. Jansen seem to me comparable to the well-known roles introduced by Costello and others as a syntactic supplement to Taube's uniterms.

"However, it is a new point of view to include indicators of aspects etc. in the thesaurus itself, which is usually regarded as a semantic /not a syntactic/ tool, comparable to a vocabulary".

Wednesday, 25th March 1970, Morning session.
Chairman: J. Gravesteijn

After approval of the minutes of the meetings on March 24th, the discussion continued on point 4a: methods of building thesauri for overlapping fields.

Mr. Toman mentioned the fact that thesauri are not the first tools of indexing and retrieval in the history of documentation and that many publications have been written on subject headings, conventional classification systems and faceted classification in the past. This knowledge and experience should be used for the benefit of the construction of modern thesauri.

In conventional information systems UDC played an important role in many countries, being the integrating factor in the network of information centres. Introducing special thesauri would mean atomizing this network. Each information centre in each country is building its own thesaurus without regard to neighbouring fields and to similar information centres abroad.

On the other hand it is clear that a mechanized information system needs deep indexing and this demands an ordering system made to measure and not a universal system. We must realize that the problem of the relation of special and universal ordering systems is of capital importance to this and other similar conferences. The question of relations between the thesaurus for a special field and some superstructure, perhaps of very generic character, must be solved.

Mr. Rolling gave an example of compatibility between several thesauri in the same field /metallurgy/ and of compatibility between thesauri in different overlapping fields /nuclear sciences and metallurgy/.

UNESCO is fully aware of the problem of proliferation and Mr. Wysocki mentioned the existence of the two clearing houses in Warsaw and Cleveland dealing with thesauri.

Mr. Leski stated that there must be valid reasons which impelled information specialists to work on other ordering systems than classification systems. After having changed from a formal to a language system, the problem is now to establish compatibility between the existing thesauri.

The disadvantages of classification systems were discussed by Mr. Mojžišek, Mr. Jansen, Mr. Aitchison and Mr. Lloyd, as far as file handling in overlapping fields and communication between user and file are concerned.

Mr. Wysocki pointed out that an integration of thesauri in a general system is one of the aims of the UNISIST project. In this project two systems are distinguished:

a/ A broader scheme of classification

b/ Thesauri for the different branches of knowledge.

After discussion the assembly concluded on the proposal of Mr. Rolling that we can distinguish three different levels in ordering systems:

1/ A specific level serving for indexing and retrieval purposes.

2/ A general level to assure compatibility between thesauri.

3/ A classification system that plays an organizing role.

The factors influencing the compatibility of thesauri in related fields are:

- homonyms
- synonyms
- relations between terms belonging to different fields
- point of view when considering descriptors from one field or another.

The need for cooperation in establishing thesauri in the same field and in overlapping fields was admitted by the assembly.

Mr. Mojžišek stated, however, that the problems related to overlapping fields can only be resolved from the point of view of each field concerned.

A lecture by Mrs. Bellert on the linguistic approach to thesauri building was a welcome contribution to the discussion, and it clarified some of the terms used earlier.

Point 4a: Methodological problems in the establishment of multilingual thesauri.

The chairman described the activity of ICSU-AB. The project for a multilingual thesaurus in the field of geology was mentioned /English, French, German, Russian/.

Some complementary information on existing multilingual thesauri was given by Mr. Rolling. The languages used in the case of the thesaurus of the DIRR /Roads/ are English, French, and German. The languages are English, German and Italian in the case of the thesaurus of the "Centro Sperimentale Metallurgico". The European Committee is also working on a multilingual thesaurus.

Mr. Leski reported that a multilingual thesaurus in the "Science of Science" field for Polish, German, Czech and Russian has been built.

Mr. Malmsten, who had already drawn attention to semantic problems when comparing thesauri in different languages, mentioned the work done by the "Comité international des arts et des traditions populaires" /8 languages/.

According to Mr. Spang-Hanssen, experience with multilingual thesauri in Scandinavia showed that these thesauri can only be established in fields with fixed terminology.

Wednesday,25th March. Afternoon Session. Chairman: T.M.Aitchison

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POINT 4a ON AGENDA: METHODS OF BUILDING THESAURI

The discussion of this item was continued from the morning session.

Mr. Jansen stated that the IDC thesaurus is multilingual in German and English and to a lesser extent in French. It is used by them in indexing papers in these languages.

Mr. Leski explained that his group used only descriptors and candidate descriptors. If a precise descriptor could not be found an auxiliary term in a foreign language might be used, but controlled terms were required in social sciences.

Mr. Rolling stated that there were two types of multilingual thesauri: those which were built up simultaneously in each language, and those in which the thesaurus in one language was translated into other languages.

Mr. Robowski referred to his experience in dictionary preparation. It was impossible to translate terms from one thesaurus to another: instead one should translate concepts, i.e. descriptors as classes, not according to the exact meaning of the words.

Mr. Maixner considered it advisable to translate whole sentences rather than word for word. One might try to do this by machine, but the problem of machine translation had not been solved.

Mr. Lloyd did not agree that one could not translate one thesaurus into another.

Mr. Jansen suggested that while 90% of the words might be translated satisfactorily, in 5% to 10% the translation would produce noise.

Mr. Leśki agreed with Mr Rolling's division of multilingual thesauri into two types. He considered that the same scheme must be used for both thesauri if they were to be compatible.

Mr. Varga suggested that concepts were different in different languages and that one could translate from a language with broad concepts, but not the other way round.

Mr. Rosenbaum suggested that concepts were mental things, but were expressed in words.

Mr. Spang-Hanssen considered that the conference was confusing translation of items of information with translation of vocabularies.

Mr. Lloyd stated that Mr Jansen's 5% was dealt with in other situations by retaining the word in the form of the other language, i.e. by not translating it.

Mr. Mojžišek reminded the conference that it was concerned with technical information, and that definition and precision were required.

Mr. Molnár considered that the conference was not obliged to reach agreement on methods, and that the problems belonged to the science specialist rather than the information specialist.

Mr. Jansen explained that although one can translate any sentence from English into German or vice versa, the subdivisions of the English term might be very different from those of the equivalent German term.

Mr. Lloyd thought that if it were possible to translate thesauri in special subject fields, it was possible to build thesauri in different languages within these subject fields.

Mr. Rolling stated that the assembly could either go on with the discussion for some days or reserve a time at this conference or later, depending on when the UNESCO Guidelines dealing with multilingual thesauri would be ready.

Mr. Wysocki said that the first draft was planned for July 1970.

It was agreed to leave the discussion of multilingual thesauri and to move on to the next item on the agenda.

POINT 4b ON AGENDA: METHODS OF BUILDING DESCRIPTORS

Mr. Wysocki drew attention to Items VI: "Selection of descriptors" and IX: "Methods of entering" of the Guidelines.

Mr. Rosenbaum considered that the problem had already been discussed and suggested that the meeting proceed with other items.

Mr. Malmsten suggested that in building descriptors one should be concerned also with the topology or structure /neighbourhood/.

Mr. Rolling mentioned that descriptors were added and eliminated throughout the life of a thesaurus and pointed out that this was included in the Guidelines.

Mr. Toman referred to items other than descriptors or nondescriptors: candidate descriptors and explicative words added to descriptors. He also mentioned descriptors used in parentheses in abstracts.

Mr. Aitchison mentioned the problem of degree of pre-coordination.

Mr. Toman stated that this depended on the requirements of the user.

Mr. Rosenbaum considered that machines allow any level of pre-coordination without any difficulties.

Mr. Jansen recommended that compound concepts should not be split up into less than single independent and unambiguous concepts.

The delegates agreed to provide UNESCO separately with any comments on the relevant sections of the Guidelines they wished to make.

POINT 5 ON AGENDA: CONDITIONS WHICH DESCRIPTORS AND THESAURI MUST FULFIL IN ORDER TO ENSURE THEIR INTER-BRANCH AND INTER-LANGUAGE COMPATIBILITY

It was agreed that these points had already been discussed.

POINT 6 ON AGENDA: CONDITIONS WHICH MUST BE FULFILLED BY DESCRIPTORS AND THESAURI AS TOOLS FOR FURTHER DEVELOPMENT OF INFORMATION

Mr. Leski explained that it might be that the thesaurus would only be suitable for use with given aims and at a given period of time and might not be adaptable for other information processing conditions. On the other hand, it may be a tool which could be further developed in roles other than retrieval, for example in machine analysis of texts, or in the synthesis and analysis of information.

Mr. Rosenbaum said that thesauri might be used for other purposes, including developing a science and finding relations between concepts.

Mr. Malmsten suggested another use: in standardising glossaries where a thesaurus rather than a list of terms would be provided.

Mr. Robowski doubted the future of thesauri since they could not be built up by machine and were not necessary for the machine manipulation of large numbers of documents.

Mr. Weeks suggested that thesauri might be suitable for 1960 but that something different would be required in the next few years.

Mr. Malmsten pointed out that a number of important information service required no thesaurus and suggested that this point should be discussed.

Mr. Lloyd considered, however, that at the present stage of the computer art, with comparatively small stores,high input cost, etc. thesauri were necessary.

Mr. Robowski suggested the use of glossaries or lists of keywords in fields with specialized vocabularies and for small collections of documents.

Thursday, 26th March 1970. Afternoon session.
Chairman: H.Spang-Hanssen

The conference turned to point 7 of the revised conference order, viz. organizational problems; subquestions /a/ and /b/ were treated together.

Mr. Wysocki reported on UNESCO's activities: guidelines for monolingual thesauri, to be followed during 1970 by guidelines for multilingual thesauri; the establishment of two clearing houses for English and non-English thesauri respectively; the information given in the UNESCO bulletin; and, finally, the efforts to cooperate with ISO in setting up regular standards in this field.

Mr. Varga coined the word "superthesaurus" to mean a system for ordering thesauri, and he refered to Mr. Rolling's previous remarks concerning levels of compatibility.

Mr. Rolling, Mr. Wysocki, Mr. Malmsten and Mr. Spang-Hanssen pointed to the more general nature - as opposed to a thesaurus-like nature - of an ordering system or a classification for thesauri.

Mr. Toman stressed the importance of common facets in ordering systems for this purpose, and Mr. Leski supported this view by pointing to the need of a system for common facets and auxiliary terms to deal with e.g. geography.

As a conclusion concerning organizational problems the conference recommended support for UNESCO's existing and planned activities as regards information about the building of thesauri and about existing thesauri.

The conference then returned to the previously postponed Point 3; Constructional problems, in particular Point 3a; Which elements should be included in a thesaurus?

There was agreement on the understanding of "elements", as well as various possible presentations of a thesaurus /cf. UNESCO Guidelines, Third Draft, as the elements, viz. descriptors, non-descriptors, and relational indications, to be included in various presentations.

Mr. Jansen pointed to the scheme of elements given on p. 4 of his conference paper, and he gave priority to the thematic group as an element in comparison with alphabetical listing.

Mr. Leski, referring to p. 4 of his conference paper, gave priority to the scheme /corresponding to the facet grouping in the UNESCO guidelines/ in comparison with graphic display, and in turn priority to this in comparison with alphabetical listing.

Mr. Toman and Mr. Malmsten advocated the inclusion of all kinds of references in the alphabetical listing, at least for certain practical uses, while Mr. Rolling pointed to certain inconveniences in burdening an alphabetical list with, among other things, a great number of related terms.

The indication of frequency of descriptors was mentioned as a possible element of a thesaurus, but Mr. Schiff found this to be of little value, e.g. in indexing.

Mr. Mojžíšek pointed to the usefulness of stating the date of the introduction of a new descriptor or of eliminating an absolete one to solve the problem of updating a thesaurus.

Mr. Wysocki agreed on this point and referred to the UNESCO guidelines sect. XIII. He found that what has been said about presentation was in essential agreement with the Guidelines.

Mr. Toman and others would prefer another designation than "facet grouping" for the way of presentation dealt with in section XI /b/ of the Guidelines.

Mr. Gravesteijn and Mr. Malmsten object to the concept of listing as used exclusively for alphabetic lists.

Mr. Mojžišek pointed to the value of an explanatory introduction as an element of any thesaurus, cf. sect. II of the UNESCO Guidelines.

Mr. Aitchison expressed doubt as to the relevance of the remarks about computer storage, found in sect. XI /d/ of the Guidelines.

As a conclusion concerning elements of a thesaurus, the conference recommended an explicit statement on the priority of systematic displays by rephrasing the first part of sect. XI of the UNESCO Guidelines; Third Draft in the following way:

"XI. Presentation of Thesaurus

It is recommended that a thesaurus be presented in one or more systematic displays and in an alphabetical listing.

Secondly, the conference recommends a less negative formulation as regards the introduction of structure in an alphabetical list.

Thirdly, the conference recommends that the way of presentation designated by "facet grouping" is designated also by other terms in common use for this way of presentation".

Friday, 27th March 1970. Morning Session. Chairman: D.C.Weeks

Mr. Spang-Hanssen presented a summary of the previous session, of which he was Chairman.

The initial topic of the session was the evaluation of thesauri, added to the agenda at Mr. Aitchison's request. The Chairman specified thesaurus evaluation as having these implications:

1/ the *efficiency* of its function in a system - its technical qualities,

2/ the *effectiveness*, which is a measure of the degree to which it is capable of fulfilling the user's needs and of describing the user's problem. When evaluation included comparison of two or more thesauri, then it is necessary to distinguish between thesauri that define a given domain of knowledge, and those which are specifically system-related. In the first instance, comparison cannot be based on substantive considerations since their content is different. In the second instance, their content may be similar, but their system applications may differ.

Mr. Aitchison explained his interpretation of the matter by stating that he perceived two questions: 1/ By what means can we compare the performance of a system employing a thesaurus and one that does not? Is there a way of proving the benefits in performance obtained by one of these alternatives? Evaluation implies a comparison of different forms of thesauri.

The *Chairman* added that when systems with thesauri are compared with systems having none /free-text/, we must recognize that input and processing are quite different; that the set of rules is also dissimilar and that assessment must be made by keeping the implications of those differences clearly in mind.

Mr. Toman suggested that a useful comparison might be made between systems employing other means, such as the Cranfield experiment which compared various techniques. He considered the problem to contain two distinct elements:

1/ Evaluation of other ordering systems /this would permit evaluation of the thesaurus as a tool/ and

2/ Measurement of effectiveness /assessment of the operational effectiveness in a system/.

Mr. Malmsten added the suggestion of the anti-thesaurus concept. Scandinavian systems received feed-back from industrial organizations where abstracts were used.

Mr. Mojžišek stated that all systems function on a set of rules which determine how processing is accomplished. It is necessary to analyse the file, to evaluate the retrieval requests, to make comparisons among these requests and thus to evaluate the amount of noise in an operating system. He noted the difference between an indexing language and the language of retrieval. To reconcile their differences it is necessary to develop a syntagmatic or meta-language. The existing difference - one in which a system language loses its grammar - is a principal reason for the presence of noise. Only by correlating input and output languages can this problem be solved. The Chairman stressed the gap between the efforts that have so nearly resolved problems of semantics and the minor progress toward solutions for the serious syntactic difficulties that impede system effectiveness.

Mr. Maixner emphasized the importance of Mr Mojžišek's remarks. He added that thesauri can only be evaluated as integral parts of a retrieval language; that when a thesaurus states its language in a paradigmatic way and the two are then compared, we can then observe their levels of efficiency.

Mr. Mojžišek: the rules for making a thesaurus when applied to making a system dictionary are all system-related, producing a new language which is not that of the source /document/, nor of the users. These languages need to develop a grammar which will bring all elements into correspondence.

Mr. Rolling: Apropos the Cranfield experiment, it is essential to remember that this effort was a comparison of ordering systems, all placed in the same environment as opposed to the individual, natural environments. Comparison of results is, therefore, difficult because evaluation is usually applied to systems as entities. Mr. Rolling urged continual internal evaluation of a thesaurus based on failures of recall and precision. He had found that a large percentage of failures were caused by imprecision in the thesaurus.

Mr. Aitchison reminded the group that Cranfield included two different studies. The second was able to show significant differences in coordinate indexing.

Mr. Lloyd stated that any test or measurement was not merely a test of the thesaurus but was in fact a system test. He proposed that economics was a critical factor, and in a system without a thesaurus it is possible to achieve high recall and relevance but only at a very high cost.

Summing up the topic, Mr. Lloyd offered the view that systems employing thesauri should be constantly evaluated for effectiveness and economy and the thesaurus updated accordingly.

· Definition of a thesaurus:

It was suggested by Mr. Toman and agreed upon that the assembly offer a description rather than a definition /to avoid the strictures of a formal definition/ Mr. Molnár offered a formal description of a thesaurus developed from a synthesis of conference agreements. These included matters of /1/ Order /systematic and alphabetic structure/ /2/ terms /descriptors and non-descriptors, regretting the decision to abandon the designation ASCRIPTOR/; and /3/ Interrelations /preferential, hierarchical and affinitive/.

A general discussion yielded agreement that in reference to structure, systematic order was to take precedence over alphabetic: Mr Toman reverted to his statement at the first meeting, when he observed that most ordering systems could be described by these same qualities.

Four members of the conference offered written descriptions which are included here:

1/ Mr. Molnár
2/ Mr. Rolling /These are attached/
3/ Mr. Toman
4/ Mr. Poletyło

The Chairman synthesized the proposed descriptions so as to meet these requirements:

1/ That we state the nature of a thesaurus - to what class of resources it belongs.
2/ The contents are named.

3/ Its qualities are stated
/it covers a domain/
/it is controlled, dynamic/
/it is arranged in systematic order/
4/ Its principal use:
/coordinate indexing systems/

The combined description was accepted by the conference.

x
x x

Mr. Poletyło

When we say that a thesaurus is an indexing tool, we must add what we think about coordinate indexing. Therefore the definition of a thesaurus may be as follows:

A thesaurus is the controlled vocabulary of a coordinate-indexing-language.

Consequently:

A descriptor is the preferred term in the controlled vocabulary of a coordinate-indexing-language.

A non-descriptor is a forbidden term in the controlled vocabulary of a coordinate-indexing-language.

Without adding "coordinate", the definition will be too broad. The term "coordinate" is a feature that distinguishes a descriptor language from all indexing languages, in contradistinction to precoordinate-indexing-languages as classification and subject-heading languages.

The term "controlled" distinguishes a descriptor language from coordinate-indexing-languages and from a uniterm language /which is uncontrolled/.

Mr. I. Molnár

After a 4-day conference, after many friendly and helpful discussions, after many agreements, approximate agreements and disagreements too, we have not reached an agreed definition of our fundamental topic, although discussions have taken more than 20 hours.

Could such a meeting of experts, practical creators of information systems and thesauri, not find a name for their common beautiful son?

In contrast to this, every participant in the conference has his own definitions for thesauri. It is a pity that these definitions reflect as many points of view as the number of participants.

Well, in this difficult situation, in this uncomfortable richness of definitions we have the duty to find the common characteristics of them all. This could be the first approximation of the problem. Forgive me if I begin with a rather general definition of my own. This is as follows:

1. A thesaurus is in general an ordered collection of terms which also includes their inter-relation

This includes no information on either the principle of ordering, or the nature of terms, or the branches of science, or the types and nature of inter-relations between the terms included, nor the task of the thesaurus. This definition is of such a general validity that everyone can agree with it. Everything it includes is inevitable, a "sine qua non" for a thesaurus.But this determination does not include some elements which must be further investigated.

The definition in this form is able to cover all thesauri from Roget's to the Euratom thesaurus.

I hope we can be agreed on the basis of minimum programme. If so, we are able to move on in the direction of deeper details, leading to a more detailed definition.

a/ The first element in my definition which requires further analysis is the expression ordered. This word includes the problems of the structure of a thesaurus.

We have already found agreement in relation to this expression.The material of a thesaurus can be ordered alphabetically or systematically, but it is advisable to prepare both an alphabetical and a systematical ordering.

By systematical ordering we understand the hierarchical or graphic display of terms.

b/ The second element which must be investigated is the expression terms.

We already have a common opinion on this question too. Terms are defined as consisting of descriptors and non-descriptors. I really think it regrettable that the term ascriptor is dead in "statu nascendi"/. But we are in agreement, I see, on the problem of auxiliary terms, too. These seem to be of a descriptor character.

/The definition of descriptor is not included in the definition of a thesaurus. This is for the sake of brevity/.

c/ The third element to be detailed is the expression inter-relations. We tend to agree on the recommendations of the UNESCO Guidelines and so we have three groups for inter-relationships of terms.

These are

1. preferential
2. hierarchical and
3. affinitive

relations. The common name of 1. and 3. is "non-hierarchical inter-relationships".

As a consequence of these agreements-in-detail, the second approximation of the definition could be as follows:

2. A thesaurus is in general an alphabetically or/and systematically ordered collection of descriptors and non-descriptors having hierarchical and/or non-hierarchical inter-relationships.

This second definition is somewhat more precise and of a more specialized character.

There is an unnecessary element in the definition.The third approximation is directed to words the elimination of this element, finding a better corresponding word instead. This unnecessary element is the expression in general.

This elimination can be realized only by determining the precise purpose of the thesaurus.

In the last three days we have talked a lot about the various possibilities and directions of the further development of thesauri. We have verified the science-developmental function, its science-organizing power, we mentioned the linguistic possibilities, etc. But we gave the greatest part of our discussions to the use of thesauri in indexing work, information storage and retrieval, as well as to the standardization of information queries and to the further development of scientific information.

It is well known that there is a general and essential correlation between function and structure in the living world as well as in dead material. And this correlation is valid in the case of thesauri, too.

A thesaurus, the task of which is to introduce someone into the world of science, must have a given structure which makes this possible. This structure can be a hierarchical one. Another thesaurus intended as an effective tool for indexing documents must be of alphabetically arranged structure,because this is the only way an indexer can do his job.

On the basis of this explanation it is possible to realize the third approximation for a definition of thesauri, but only when postulating its specific task.

We are information specialists. Thesauri are very important tools for our fundamental activity. Therefore we must investigate only one side of the whole problem of thesauri,and this is the side of information activity.

After this statement I feel it possible to define a thesaurus in a more exact form:

3. A thesaurus as a tool of information systems is an alphabetically and/or systematically ordered collection of descriptors and non-descriptors having hierarchical and/or non-hierarchical inter-relationships.

This definition seems to correspond to our information tasks, though it includes no statements in connection with traditional or computerized uses. But it would be incorrect because of the relatively great number of existing traditional systems.

Other thesauri for other purposes can be otherwise defined.

Mr. Rolling

A thesaurus is a controlled but dynamic vocabulary of semantically related terms offering comprehensive coverage of a specific domain of knowledge.

Its main use is in the subject characterization of documents and queries in information storage and retrieval systems based on concept coordination.

Its principal elements are descriptors, non-descriptors, terms and relationship indicators.

It generally comprises one or more systematic displays and one or more alphabetical listings.

Mr. Toman

A thesaurus is a system of controlled terms used for characterizing the content of documents /information/ in storage and/or retrieval systems. It is characterized in its dynamics by a weak hierarchy, by preferring postcoordination to precoordination. In contrast to classification systems, it displays affinitive terms but does not use notation and categories.

Friday, 27th March. Final Session-11.45 a.m. Chairman: K.Leski

The session was devoted to the problem of formulating conclusions embracing the results of the whole conference. The following conclusions were taken:

I. A thesaurus is a lexical tool of information retrieval systems. It consists of a controlled but dynamic vocabulary of semantically related terms. This vocabulary,which comprehensively covers a specific domain of knowledge, is a systematically and alphabetically ordered collection of descriptors,non-descriptors /auxiliary terms/ as well as indicators of their relationships both hierarchical and non-hierarchical.

Unlike classification systems a thesaurus does not necessarily use notations and categories.

Its main use is in the subject characterization of documents /information/ and queries in systems based on concept coordination.

When discussing the question of the display of descriptors, the importance of the systematic display, whether in thematic, hierarchical or graphical form, or all of them together, was stressed. It was recommended that the UNESCO Guidelines put the systematic display before the alphabetic in their wording.

II. The main role of a thesaurus is to ensure that indexing and retrieval of documents can be affected with a maximum of precision and completeness.

In addition, the existence of a thesaurus covering a subject field tends to stabilize the terminology of this field.

In particular:

- Thesaurus work leads to the formulation of more precise definitions of inconsistently-used terms.
- New terminology is properly defined and given its preferred place in the semantic structure of the vocabulary.
- Editors could use thesauri in advising authors to use correct terminology in their publications /particularly in titles, which are used for KWIC and other indexes/.

- Editors could use thesauri for preliminary logging of articles or abstracts, thus facilitating the work of subsequent scanners and indexers.
- Dictionaries should include mention of preferred terminology in the major thesauri.
- Thesauri constitute the starting point for elaboration of the more complex lists of words used in free-text processing.

Systems employing thesauri should be continually scrutinized and evaluated in terms of recall, relevance, and economics: and the thesauri should be updated accordingly.

III. Three types of factors influence the elaboration of thesauri:

1. Factors related to subject area and language
   - volume of literature to be covered
   - language distribution of this literature
   - redundancy /or lack of precision/ of terminology
   - overlapping with fields already covered
2. Factors related to the user population
   - degree of precision required
   - degree of completeness required
   - response volume required
3. Factors related to system methodology
   - equipment used /degree of mechanization/
   - storage media used
   - file organization
   - search logic

IV. The general opinion was that it was impossible to build a universal thesaurus in the sense of the detailed UDC universal system, but that if the need is felt for a superstructure covering the existing special thesauri it should be a very generic classification scheme in the sense of the recommendation made during the UNISIST control committee meeting in December 1969. It was suggested to the UNESCO delegate to provide, when constructing a general scheme, for lists of auxiliary terms and common facets from which the special thesauri could eventually draw the terms needed for the description of the form of documents and such terms which are common to many thesauri.

In order to obtain a worldwide information system, three levels of ordering systems are necessary:

1/ Mission- or discipline-oriented thesauri serving on a specific level for indexing and retrieval purposes

2/ General thesauri assuring compatibility between specific thesauri in related fields

3/ An ordering system displaying the different branches of human knowledge at a very general level.

V. The problems of multilingual thesauri were discussed exhaustively. It was agreed that there are two approaches to the building of multilingual thesauri: simultaneous construction of thesauri in different languages, and translation of a thesaurus in one language into thesauri in other languages. Similarly, there are two methods of use: simultaneous use of the thesaurus by two or more language groups, and transfer of a data base from one language to another. It was recommended that UNESCO should take account of the deliberations of the meeting in preparing their guidelines for multilingual thesauri.

The conference agreed in principle with the UNESCO Guidelines, Section VI - "Selection of descriptors" and Section IX - "Methods of entering descriptors in the Thesaurus" and agreed to provide UNESCO with their own comments.

GUIDELINES FOR THE ESTABLISHMENT AND DEVELOPMENT OF MONOLINGUAL SCIENTIFIC AND TECHNICAL THESAURI FOR INFORMATION RETRIEVAL

United Nations Educational,
Scientific and Cultural Organization[x]

Explanatory statement

At a time when the establishment of a World Science Information System is being seriously proposed[xx] it is advisable to rememember that the viability of any world system depends first and foremost on compatibility between its component parts.

These guidelines for the establishment and development of monolingual scientific and technical thesauri for information retrieval are published in an attempt to lay the basis for compatibility, both at present and in the future, of thesauri that are being elaborated simultaneously in most of the disciplines of science, basic as well as applied.

They are, therefore, directed to all those who in the course of their career come into contact with thesauri, either as users or as thesaurus compilers.

The first draft of the guidelines was prepared by the Unesco Secretariat. The third draft and this version were subsequently reviewed and studied by eminent and competent individuals and organizations and the relevant additions or corrections were made. Thus, these guidelines were presented to, and discussed by, the International Conference on the General Principles of Thesaurus Building in Warsaw, March 1970. The proposed changes are included in this version /1/. May our collaborators accept anonymity along with our gratitude.

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[x] SC/MD/20 - Paris, 6 July 1970 - Original: English
These guidelines were specifically drafted for the English language and when applied to monolingual thesauri in other languages they should be modified to take into consideration the attributes and uses of that particular language.

[xx] Joint Unesco-ICSU study on the feasibility of a World Science Information System /UNISIST/ Final Report. Unesco, Paris, 1970.

Fourteen guidelines are presented: the first four are of a general nature, the following seven deal with the establishment of thesauri, and the final three relate to the development of thesauri. Examples, where appropriate, are given on the right-hand margin of the text. By the word "thesaurus", as used in the present text, is meant a controlled and dynamic vocabulary of semantically and generically related terms which comprehensively covers a specific domain of knowledge. This vocabulary is a systematical and/or alphabetical collection of descriptors, nondescriptors /auxiliary terms/ as well as indicators of their relationships. Unlike classification schemes, the vocabulary does not necessarily use notations and categories.

A descriptor is an authorized and formulized term or symbol in a thesaurus, used to represent unambiguously the concepts of documents and queries /2/.

Thesauri should be based on concepts and relationships which are internationally acceptable. Original and translated thesauri already exist in most of the major vehicular languages used in science and technology today. It is rare that any particular word can be translated univocally into another language without losing some shade of meaning in the process, but it is hoped that the application of these guidelines to monolingual thesauri will diminish the enormous difficulties encountered in the establishment of thesauri in different languages. These guidelines were originally drafted in English and when applied to monolingual thesauri in other languages, they should be modified to take into consideration the attributes and uses of that particular language /e.g. number of descriptors, VIII b/.

Thesauri can be used in many ways, and the structure of a thesaurus is intimately related to its proposed utilization. A thesaurus can be used merely as a word association list for helping indexers, or it can be considered as a transformation of the natural language into the information language /3/.

Modern techniques in information science are nearly all based on the use of electronic computers and it is in this connexion that the use of thesauri is rapidly proliferating.It is this rapid proliferation which has brought the need for international guidelines to light and it was for this reason,too, that Unesco recently encouraged /helping in the establishment of one/ the work of two clearing-houses dealing with thesauri. These clearing-houses are located at the Bibliographic Systems Center, School of Library Science, Case Western Reserve University, Cleveland, Ohio 44 106, United States of America, and at the Centralny Instytut Informacji Naukowo-Technicznej i Ekonomicznej, Al. Niepodległości 188, Warsaw, Poland for English and languages other than English respectively.

General

I. Advisability of a pilot run

Before establishing a thesaurus on a definitive basis it is strongly recommended that a practical test, based on a restricted number of documents dealing with a small area of the domains to be ultimately covered, be carried out. This pilot run, based on tentatively structured terms, should show up the more adequate methods of descriptor selection and thesaurus display applicable to the case under consideration. The results of this test should be critically commented upon by as many people as feasible, including information scientists and indexers as well as subject specialists and users.

II. Necessity of a descriptive introduction to the thesaurus

No thesaurus should be presented without a comprehensive introduction which states clearly the purpose and structure of the thesaurus, and the domains covered by it. The rules followed in its establishment should be presented in a condensed form.This is particularly true of the methods and sources used in the selection, form and avoidance of ambiguity of the descriptors /see VI, VII, VIII/.The method of presenting the thesaurus as well as the rules for alphabetization and punctuation, whenever applicable, should be explicitly stated.

Most important of all, the rules for using the thesaurus and its limits of applicability should be elucidated and illustrated by means of examples, where appropriate.

Users should be invited to contribute comments and suggestions for the improvement of the thesaurus, and to inscribe themselves on the mailing list for future editions of or additions to the thesaurus. The proposed system for developing and up-dating the thesaurus should be explained; the date of the present, and estimated appearance of future, editions or additions to the thesaurus should be given.

The total number of descriptors, non-descriptors /4/,identifiers, /see VI/, hierarchical chains /see X/b// and related concepts /see X /c// should be itemized.

III. Necessity of indexes

Every thesaurus, regardless of its mode of presentation /see XI/ should contain an alphabetical union list of each individual unstructured term /5/ whether issued separately as a supplement or together with the main thesaurus as an annex.Permutation indexes may also be used.

It may be useful in the case of multidisciplinary thesauri to present, in addition, indexes in which the descriptors are grouped by discipline.

IV. Notification of intent

The appropriate clearing-house /see above/ should be notified of the intention to construct a thesaurus, as well as when the thesaurus is first published or disseminated. This information should be channelled through the national organization dealing with thesauri, where and when such an entity exists.

The same applies for further editions. If at all possible, a copy of the thesaurus, complete with the introduction and indexes should be sent to the clearing-house in question. The fact of notification should be mentioned in the introduction.

Establishment

V. Check with clearing-house to avoid duplication

Before commencing work on the establishment of the thesaurus, it is advisable to ascertain whether others covering that particular domain or a neighbouring one are available.

This is best done by addressing a query to the two clearing-houses mentioned above. It may be found advisable to go ahead with the compilation of a particular thesaurus in spite of the existence of a similar one. In this case the reasons for proceeding and the differences with the earlier thesaurus should be clearly stated in the introduction.

VI. Selection of descriptors

The selection of descriptors should begin only after the general structure of the thesaurus has been agreed upon. It should be carried out, preferably, by people who have both a good knowledge of the subject to be treated, and previous experience in indexing or classification. The use of internationally recruited teams for the construction of thesauri is to be encouraged since it widens the cumulative linguistic experience which goes into the building of the thesaurus. The methods of selecting descriptors vary according to the proposed structure of the thesaurus /alphabetical listing, systematical listing /6/, graphic display /6/, see XI/, the purpose for which the thesaurus will be used /e.g. for manual or mechanical retrieval, only for indexing, or as a secondary tool/ and the background to the project /gradual build-up to mechanical processing, introduction of a new domain e.g. interdisciplinary areas for which no previous classification schemes existed, existence of well-defined group of users and subject specialists, extensive literature/.

Acoustical
Holography
Brain
Research

Descriptors, in general, consist of terms related to discrete concepts encountered in the subject field under consideration and in pertinent marginal areas. A more specific class of thesaurus terms /7/ known as "identifiers" may sometimes be used.

Descriptors should succinctly summarize concepts in as few words as possible,preferably one. Grammatical connexions such as prepositions or articles should be avoided whenever possible.

Identifiers constitute a special type of thesaurus terms /8/ which are not reciprocally cross-referenced /see XI/ and which serve the purpose of providing additional indexing depth. For instance, identifiers might include individual trade names, geographical locations, equipment, nomenclature, code names etc.

IRELAND
NT DUBLIN
DUBLIN

Since they are not reciprocally cross-referenced, identifiers need not necessarily appear in the thesaurus display, but may be listed separately, in addition to appearing in the Union List /see III above/.

Four distinct steps intervene in the selection of descriptors: collection, verification, evaluation, and choice.

/a/ Collection

It is almost impossible to make a comprehensive collection of candidate descriptors by tinking of an alphabetical list. By envisaging descriptors in groups, thought associations between them give rise to many candidates. Potential users and subject specialists as well as internationally or nationally standardized technical dictionaries should be consulted; terms should be chosen from the current literature; existing word lists or classification schemes should be culled and may be expanded or compressed appropriately. Scientific and technical dictionaries and glossaries, both multilingual and monolingual constitute a prolific source of descriptors /see page 182/.

/b/ Verification

With all methods of assembly, the authenticity of the selected descriptors should be verified by consulting dictionaries, other indexing or standardized vocabularies, current usage in the literature and especially the opinion of subject specialist. Obsolete terminology should not be included, or if so only as forbidden terms /see X /a/ below/.

One of the more appealing attributes of a thesaurus is its ability to assimilate immediately the neologisms and special jargon that proliferate in expanding fields of basic and applied research. Full advantage should be taken of this facility in combination with the use of scope notes /see VII /c/ below/ and cross-references. Special care should be taken with terms whose connotations have changed with the passage of time, or whose meaning changes from country to country. If overlapping terms have to be included the appropriate cross-reference /see X below/ should be employed.

BILLION/10 EXP 9/
BILLION/10 EXP 12/

/c/ Evaluation

In evaluating the utility of candidate descriptors, reference should be made to their:
1. frequency as encountered in the literature or in the existing stocks of information/9/;

2. anticipated incidence in retrieval inquiries;
3. relationship to descriptors already accepted;
4. appropriateness and authenticity as current terminology in the discipline concerned; 5. effectiveness and expediency in connoting and denoting the particular concept. None of these factors should be considered independently and particular attention should be paid to areas of peripheral interest where the exhaustivity and specificity required of the descriptors are not the same as for the core subject.

/d/ Choice

In all cases, descriptors should be selected for inclusion in the thesaurus on the basis of their estimated effectiveness for retrieval purposes and their measureable significance in the material to be indexed.

VII. Methods of avoiding ambiguity

In compiling a thesaurus, difficulties are encountered with descriptors which have more than one accepted meaning or whose meaning in a given context is different to that commonly encountered. In such cases the required meaning may be brought out by the use of the following methods:

/a/ Compound expressions

Although descriptors are preferably self-contained, single term concepts, the use of modifying expressions to make clear the different meanings associated with a given term is necessary in certain cases. For the method of entering the resulting compound expression,/see IX/a/ below/.

LATENT
HEAT

/b/ Qualifiers for homonyms

The various forms of homonyms may be distinguished by the use of qualifying expressions placed between parentheses immediately after the homonym. Other homonyms should not be used as parenthetic qualifiers.

BEAMS
/ELECTROMAGNETIC/
BEAMS
/STRUCTURAL/

/c/ Scope notes

A scope note is a brief explanation which may accompany the descriptor in the thesaurus display, but does not form part of the descriptor. It indicates the way in which the descriptor should be used; it need not necessarily consist of a dictionary definition. Scope notes are sometimes used to restrict the usage of a descriptor. They should always be used in connexion with abbreviations and acronyms /see VII /d/ below/.

It is recommended that either /a/ and /c/ or /b/ and /c/ above be used together in a single thesaurus. Methods /a/ and /b/ should be mutually exclusive and never be used in one and the same thesaurus.

[x]DOCUMENTATION
The process of storing and retrieving information in all fields of learning.
[x]DOCUMENTATION
The volume of documents assembled or available.
[x]DOCUMENTATION
The title of a family of publications.

VIII. Form of descriptors

/a/ Word form

Once it has been decided to include a given term in the thesaurus, care should be taken to ensure that the word form used adequately conveys the exact meaning intended.

/i/ Spelling: the most widely accepted spelling of the word should be used. Cases arise, particularly in English, due to varying usage on different sides of the Atlantic, where more than one spelling of a word is accepted, in which case both forms of the word should be included in the thesaurus. In these cases the preferential cross-reference should be employed /see X /a/ below/. Alternatively, a well-established dictionary can be chosen to act as arbitrator whenever this problem arises.

SULFUR
SULPHUR

/ii/ Translation: many current technical terms have arisen by translation from other languages, but sometimes a modern foreign language or Latin term is incorporated into the specialized vocabulary for a particular subject. When both the foreign language term and its putative translation coexist, they should both be included in the thesaurus and cross-referenced preferentially.

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[x] For instance, in three different thesauri. If these three meanings were in the same thesaurus, they would require qualifiers in order to make them unique.

BRAKING RADIATION
BREMSSTRAHLUNG

/iii/ Transliteration: the problem is further complicated when the foreign language in question is written in a different alphabet. This is particularly true in the case of identifiers /see VI above/. The transliteration standards[x] recommended by the International Organization for Standardization should be used whenever applicable. Wherever a choice exists the transliteration which does not employ diacritical marks should be selected /see /e/ below/.

SATELLITE
SPUTNIK

/b/ Noun form

The descriptor should be in the form of a noun or that part of the verb which is grammatically equivalent.

The gerund in English

/c/ Number

In general, the plural form should be used for descriptors, particularly when generic terms are involved. The singular form is used for specific material or property terms, process terms, proper names and disciplinary areas. Sometimes the singular and plural forms of a word denote different concepts; in this case both should be entered.

FORCES
HEATING
PALYNOLOGY
TEAK
WOOD
WOODS

/d/ Abbreviations and acronyms

Abbreviated word forms should be used only when their meaning is internationally established. Both abbreviated and unabbreviated forms should be displayed and cross-referenced preferentially. Sometimes the necessity for limiting the length of the descriptor /see /e/ below/ entails the use of less well established abbreviations. In all these cases a scope note /see VII /c/ above/ should be appended.

---

[x] See page

UNESCO
United Nations
Educational,
Scientific and
Cultural
Organization

The above remarks also apply to acronyms.

/e/ Character set

Since the majority of scientific and technical thesauri now being established will probably be used in connexion with electronic computers, it is advisable to use only the upper case format for the descriptors. Diacritical marks should be avoided for the same reason.

The need for these restrictions will probably disappear in the near future, as the fruits of technical advances become more widely distributed, and computer manufacturers pay more heed to the exhortations of information scientists to lower the costs of peripheral equipment.

As mentioned in /d/ above, the eventual use of a computer may entail the limiting of the number of characters that a descriptor may have.

/f/ Special characters and numerals

The only special characters allowed in descriptors are left and right parentheses and unavoidable hyphens. /Fullstops may sometimes be used /see IX /b/ below/. Any other non-alphanumeric symbols should be confined to scope notes, always within the limits of machine character availability. If the descriptors contain numeric elements, arabic numerals should be used. The position of the numerals should follow normal usage. Rules must be established for the treatment of subscript and superscript numerals.

MERCURY
/PLANET/

In the particular case of data retrieval thesauri, the stroke /"/"/ may sometimes be found necessary.

EH/M

IX. Methods of entering descriptors in the thesaurus

/a/ Syntax

Compound expressions consisting of two or more words should be listed preferably by direct entry i.e. not artificially inverted. This is especially true for /10/descriptors: for forbidden terms, this recommendation may be relaxed. Evidently this does not apply when a permuted or key word in context type of multiple entry is used. Inverted entries may be used provided they are preferentially cross-referenced /see X /a//. When a qualifier between brackets /see VII /b/ above/ forms part of the descriptor it is advisable to enter the qualifier on its own with a preferential cross-reference to the complete descriptor.

ELECTRICAL POWER
not
POWER, ELECTRICAL

/b/ Punctuation

Punctuation marks should not appear in the descriptors. As stated in VIII /f/ above, the only non-alphanumeric symbols normally allowed in the descriptors are left and right parentheses. Fullstops should only be allowed when, due to a limit on the length of the descriptor, a word has to be truncated. Hyphens should only be used when their omission would alter the intended meaning of the descriptor. Commas, colons and apostrophes should be excluded since they are not necessary to convey the meaning of the terms. Where punctuation marks are omitted, it is advisable to include them in full in the scope notes.

LIGHT-SENSITIVE DEVICES
HIGH-VOLTAGE PYLONS

/c/ /i/ Specialized vocabularies

Certain fields have highly specific systems of nomenclature, or well-established standardized technical vocabularies. Whenever an internationally agreed nomenclature exists, it should be used.

/ii/ Specific names

The proliferation of unrelated specific names would tend to convert the thesaurus into a simple list of identifiers which would be selfdefeating. It is therefore recommended that the names of unrelated specific entities be avoided as much as possible.

/iii/Specific items

Descriptors representing generic, functional or structural concepts can be co-ordinated to denote specific items, while by retaining the property of being cross-referenced, they fulfil the structural needs of thesaurus elements.

/d/ Alphabetization

Where appropriate, one of the following alphabetization methods may be followed:

/i/ letter by letter
/ii/ word by word
/iii/ computer sort

The selection of the method of alphabetization depends on all the factors affecting the thesaurus under construction. i.e. the size and structure of the domains covered by the thesaurus, the availability of machine processing, the kind of hardware available, etc. In all cases the alphabetization rules should be clearly and explicitly drawn up before any kind of ordering is attempted.

/e/ Synonyms and quasi-synonyms

It is rare that two or more candidate descriptors can be considered as true synonyms. When one candidate descriptor must be searched every time that another is searched, they may be treated as synonyms. Descriptors that overlap significantly or represent different aspects of the same property may be considered quasi-synonyms. Antonyms should be similarly treated. When all the synonyms, quasi-synonyms or antonyms are included in the thesaurus display the preferential cross-reference should be used /see X /a/below/.

COLUMBIUM/NIOBIUM

HEREDITY/GENETICS

HARDNESS/SOFTNESS

X. Interrelationships between descriptors*

The most important function of a thesaurus is to serve as a tool for information retrieval. Therefore it should bring into evidence the interrelationship between individual descriptors. These can be expressed by several means. If codes are used to indicate these relationships, their meaning should always be made clear.

These interrelationships are of three types: preferential; hierarchical; affinitive. All three have the property of reciprocity, i.e. when two or more descriptors are related in any way, reciprocal entries are required. /Identifiers /VI above/ are the only exceptions to this very important rule./

This is necessary of the homogeneity of the thesaurus and for "book-keeping" purposes.

/a/ Preferential

This reference is employed to refer from a forbidden term to /11/ a descriptor and *vice versa*. It is used when the meaning of descriptors overlaps substantially; where different spellings of the same word exist; for synonyms, quasisynonyms and antonyms and, in general, wherever a choice has been made between a number of descriptors, all of which are included in the thesaurus display.

Common codes in English are: use/ /includes use/USE// /used for /UF/

ALCOHOLS
USE ALKANOLS
ALKANOLS
UF ALCOHOLS

/b/ Hierarchical

Hierarchical relationships are used to exhibit relative degrees of specificity within a category of descriptors all of which belong to a particular generic group. This relationship is not based upon the possible use or application of an entity, but on the position of the descriptor within a given class of concepts. Note that certain terms may be members of more than one hierarchical chain. Where any hierarchy has more than two levels the cross-references for all levels should be completed for each descriptor. The kinds of hierarchical relationships which it is desirable to indicate depend on the structure of the subject field of the thesaurus. In general, all concepts which are sub-divisions of a broader concept should form part of a hierarchical chain.

Common codes in English are: broader term /BT//narrower term /NT/ specific to/generic to

CALCULUS NT INTEGRAL CALCULUS

INTEGRAL CALCULUS BT CALCULUS

Genus-species in zoology

Whole-part

Subordinate concepts

/c/ Affinitive

The affinitive relationship is employed to refer from a descriptor to others that are closely related in concept but are neither consistently hierarchically nor preferentially related. This relationship may be based on usage, application, physical proximity, etc.

Common codes in English are: related term /RT/ also see

EDUCATION
RT LEARNING
LEARNING
RT EDUCATION

XI. Presentation of thesaurus

It is recommended that a thesaurus be presented in one or more systematical displays and alphabetical listings /12/.

/a/ Systematical listing

Systematical listing /13/ refers to that form of thesaurus display in which descriptors are first of all grouped in general class categories within each of which the interrelationships between the descriptors, particularly the hierarchical relationships, are as self-contained as possible. Full use should be made of recorded experience in the field of classification when establishing the membership of the various facets.

Some descriptors may appear in more than one category but this should occur only when either the descriptor is accompanied by a parenthetical qualifier or when cross-references are used.

Thesauri that are presented in this way should always contain an alphabetical listing of all the terms included in the thesaurus /see III above/.

Systematical listing /14/ is probably better for very specialized scientific and technical fields than for interdisciplinary areas.

Combination of this type of display with /c/ below gives rise to a kind of structured alphabetical list which probably combines to the fullest extent the advantages of both.

/b/ Graphic display

Perhaps the most subtle mode of presentation of thesauri is to display the descriptors and the relationships between them graphically. Although this can be done multi-dimensionally, for instance by taking two dimensions for each facet of a multi-faceted thesaurus, the more current methods are two-dimensional.

One such system consists of arranging the descriptors in semantic groups, assigning a gridded sheet to each group and giving fixed positions to each descriptor with respect to the horizontal and vertical axes, thus defining co-ordinates.

Interrelationships between descriptors are then shown by means of arrows. Associative relationships are denoted by bi-directional arrows. Hierarchical relationships are shown by unidirectional arrows always pointed to the more specific descriptor. Preferential relationships may be indicated by brackets with the arrows leaving or arriving at the preferred term.

It is understood that a descriptor may belong to several groups. The optimal size of each group appears to lie between 30 and 40. As before, an alphabetical listing should be given in annex showing the semantic group/s/ to which each descriptor belongs. Which mode of presentation is selected will depend on the use to which the particular thesaurus will be put.

The latter two types of display lend themselves more easily to translation. A rather particular type of thesaurus is the following.

/c/ Alphabetical listing

The great advantage of an alphabetical listing is that the introduction and correct positioning of new descriptors is very easy. On the other hand, it is extremely difficult to introduce structure into a strictly alphabetical list. For instance, synonyms come more readily to mind if we think of a particular category as a whole rather than individual descriptors plucked at random from an alphabetical list. It should be remembered that a particular alphabetical order is only applicable in one language. Permuted alphabetical lists may also be used /15/.

Development

XII. Periodic verification of usefulness of individual descriptors

At least for the first few years, if not permanently, after the establishment of a thesaurus, a check should be kept on the frequency with which particular descriptors are utilized, both for indexing and retrieval purposes. Periodic verification should ensure that certain descriptors neither interfere with, nor duplicate one another. On all occasions in which a search does not locate the desired information or the amount of information suspected of being in the collection, a critical appraisal of the descriptors which were, or should have been used, ought to be carried out.

XIII. Elimination of descriptors

If it is found that any descriptor is being used very infrequently, care should be taken to ensure that the infrequency of usage is not due purely to the lack of documents related to that particular concept. It may either be eliminated from the thesaurus or replaced by another more common term. Complete elimination should occur ideally only when that particular descriptor has never been used, either for indexing or retrieval purposes. The use of a preferential relationship to indicate where the replacement has been effected is more practical.

The inverse is also true: if too many indexed materials are assigned to the same descriptor, its specificity is lost, its application has become too general and the breaking-down of the concept should be considered.

If a preferential relationship is not used, the date of introduction of a new descriptor into the thesaurus should be noted since, prior to that date, indexers were not authorized to use that term.

The procedure to be followed when a particular descriptor is over or under used depends to a certain extent on the search strategy employed in retrieval. If the least specific descriptor is searched for last, it may not be worthwhile to eliminate it.

XIV. Choice of new descriptors

Indexers and users should constantly be on the look-out for new candidate descriptors which may represent either new concepts or different facets of old concepts. If possible, the descriptor should be used on a trial basis by indexers for some time before becoming a definite addition to the thesaurus.

The frequency of occurrence of such candidate descriptors both as indexing and retrieval terms is a good indication of their future usefulness. If it is decided to add a new descriptor, the interrelationships with all the pre-existing descriptors should be identified and introduced in the appropriate places.

Definite additions should not be introduced singly as this causes confusion among the users of the thesaurus. New descriptors should be saved up and introduced by batches, either as "additions to the thesaurus" or on the occasion of a new edition of the thesaurus. This does not preclude their use by indexers. There should exist a central authority which examines all the suggestions received and issues a final verdict on the acceptability or otherwise of the possible new additions.

It should always be remembered that a thesaurus is never completed, its size and shape being a function of time.

Note: Numbers in brackets from /1/ to /15/ signify places in which the final text "Guidelines for the Establishment and Development..." differs slightly from the text of Project 3.

List of ISO recommendations related to these Guidelines

ISO/R 9	"International sytem for the transliteration of slavic Cyrillic characters" 2nd edition.
ISO/R 233	"International system for the transliteration of Arabic characters".
ISO/R 259	"Transliteration of Hebrew".
ISO/R 704	"Naming principles".
ISO/R 843	"International system for the transliteration of Greek characters into Latin characters".
ISO/R 860	"International unification of concepts and terms".
ISO/R 919	"Guide for the preparation of classified vocabularies".
ISO/R 1087	"Vocabulary of terminology".
ISO/R 1149	"Layout of multilingual classified vocabularies".
ISO/DR 1951 /Draft/	"Lexicographical symbols, particularly for use in classified defining vocabularies".

The above documents are available either from the Headquarters of ISO /International Organization for Standarization/, 1 rue de Varembe, Geneva 20, Switzerland.
or from: the corresponding National Standards Organizations of the member countries of ISO.

Sources for dictionaries and glossaries:

Bibliography of interlingual scientific and technical dictionaries, 5 ed. Paris, Unesco, 1969. 250 p.

Bibliography of monolingual scientific and technical glossaries, Vol.I: *National Standards*, 1955, 219 p. Vol. II: *Miscellaneous Sources*, 1959, 146 p. Paris, Unesco.

/Supplements published in *Babel*, International Journal of Translation published by the International Federation of Translators with the assistance of Unesco. Avignon, France./

Bibliographic Bulletin of the Clearinghouse at CIINTE, 1969, Warsaw, CIINTE, 1969, 140 p. /Annual supplements are planned./

Bibliographic Systems Center Subject Index, Case Western Reserve University, Cleveland, Ohio, U.S.A., 1969. /Computer print-out./

Some national standards institutions publish extensive unilingual and sometimes bilingual technical vocabularies.

QUESTIONNAIRE ON PROBLEMS THOUGHT DESIRABLE TO RAISE BEFORE THE MEETING

1. Definition of a thesaurus
   - a/ what does "thesaurus" mean?
   - b/ which structural elements /semantic, syntactic etc./ should be included in order to be able to call a given construction "a thesaurus"?
   - c/ which elements and factors influence the organization of a thesaurus?
   - d/ how should the degree of complexity and the number of information items contained in a thesaurus be evaluated?

2. Is the concept of a thesaurus sufficiently complete and univocally and exhaustively defined, or does it necessitate further analysis?

3. What is the role of a thesaurus?
   - a/ direct use in information and retrieval systems
   - b/ in development of scientific information

4. How can thesauri be constructed?
   - a/ methods of compiling thesauri
   - b/ possibilities and advantages of automation in compilation of thesauri

5. How can thesauri be classified?
   According to:
   - a/ branches /subject/
   - b/ accuracy of definition of concept relations
   - c/ the degree of hierarchy

d/ adopted types of basic components
e/ coding methods?

6. **How can we define a descriptor?** /Conditions which a key-word must fulfill in order to become a descriptor - the methods of constructing descriptors/.

7. **What conditions must descriptors and thesauri fulfil in order to ensure their inter-branch and inter-language correlation?**

8. **What conditions must be fulfilled by descriptors and thesauri as tools for the further development of information?**

We consider the above topics only as general outlines, and would be grateful if you widen the scope of the subject matter. If in your opinion it is not necessary to discuss all the items, please give your opinion only on such points which you consider to be of utmost importance.

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Annexes

Annexes to the article:

J. Mojžišek, Statistical Analysis

of Documentation Files-SADF see page: 59-62

INPUT DATA FOR THE COMPUTER CONSISTING OF INDIVIDUAL RDO's

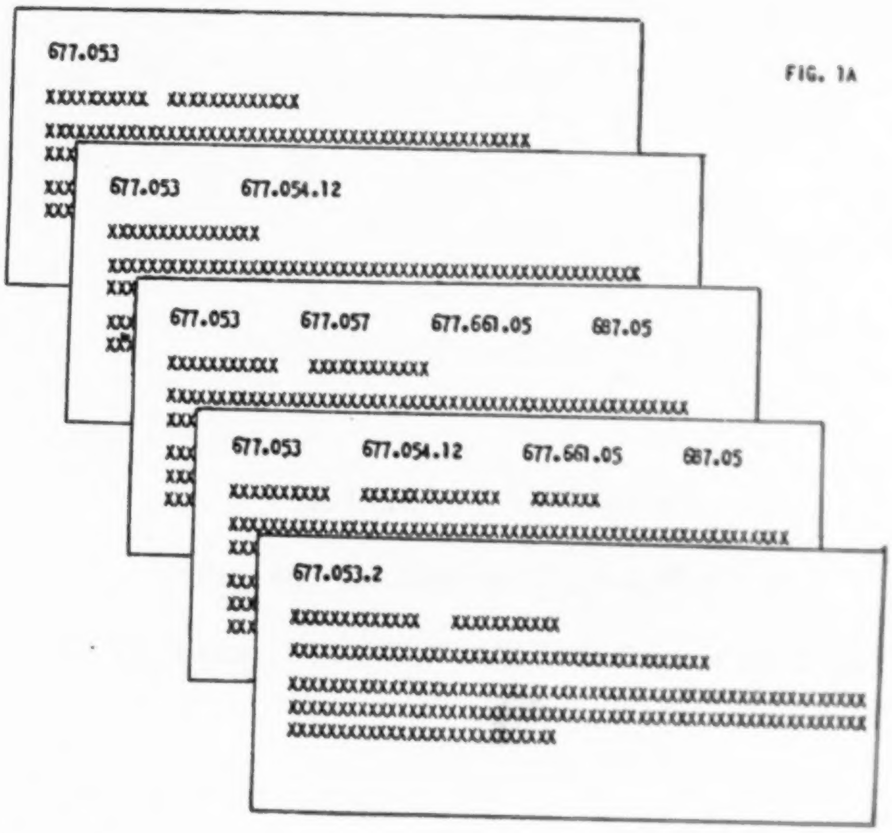


FIG. 1A

FIG. 1B

```
 .
 .
 .
2157.    677.053
2158.    677.053
2159.    677.053    677.054.12
2160.    677.053    677.057     677.661.05    687.05
2161.    677.053    677.054.12    677.661.05    687.05
2162.    677.053.2
2163.    677.053.2
2164.    677.053.2
 .
 .
 .
```

SADF-2 FIG. 1

TABLE OF SINGLE INDEXING TERMS (SIT's)

```
SIMPLE INDEXING TERM        FREK.   RANK

 .
 .
 .
 .

621.335                        1     345
621.335:2                      1     346
621.335-2.024                  1     347
621.335.025                    1     348
621.335.2                    100       6

621.335.2.024                 23      96
621.335.2.024/.025            56      29
621.335.2.025                 87      11
621.335.3.025                  1     349
621.335.42                   153       2

621.335.42-183.4               1     350
621.335.42-035                10     174
621.335.42.024                47      40
621.335.42.024/.025           11     162
621.335.42.025                67      23

621.336                        5     244
621.355                        2     311
621.355.2                      1     351
621.355.8                      3     292
621.39                         2     312

 .
 .
 .
 .
 .
```

SAOF-2 FIG. 2

SURVEY OF SINGLE INDEXING TERMS (SIT's) FUNCTIONING

JADF-2

FIG-3

RANK	SINGLE INDEXING TERM												
	FREKV. JPZ	PROC. DOK.	PROC. JPZ	KUM.PROC. JPZ	ENTROPIE PRIR.	ENTROPIE CELK.	RANK KPZ	FREKV. KPZ	PROC. K JPZ	RANK KOMB JPZ	FREKV. DVOJICE JPZ	PROC. DVOJICE K JPZ	POCET KPZ S DVOJICI
1	2	3	4	5	6	7	8	9	10	11	12	13	14
③	625.282-833.6												
	136	2,8	1,9	6,3	,101	,3254	526 ●	1	0,7	4	11	8,1	6 ●
							558	1	0,7	5	4	2,9	1
							575	1	0,7	6	4	2,9	2
							577	1	0,7	8	1	0,7	1
							586 ●	1	0,7	11	1	0,7	1
							595	1	0,7	13	1	0,7	1
							649	1	0,7	15	1	0,7	1
							656	1	0,7	17	1	0,7	1
							678	1	0,7	19	1	0,7	1
							696 ●	1	0,7	21	2	1,5	2
							710	1	0,7	26	5	3,7	4
							802	1	0,7	28	2	1,5	2
							805	1	0,7	29	2	1,5	2
							1019	1	0,7	32	1	0,7	1
							1021 ●	1	0,7	36	1	0,7	1
							1042	1	0,7	45	2	1,5	2
							1107	1	0,7	46	2	1,5	2
							1108	1	0,7	50	3	2,2	3
							1109	1	0,7	52	2	1,5	2
							1321	1	0,7	56	2	1,5	2
							1524	1	0,7	62	1	0,7	1
							1538	1	0,7	70	1	0,7	1
							1539 ●	1	0,7	71	1	0,7	1
							290	2	1,5	74	1	0,7	1
							330	2	1,5	76	1	0,7	1
							210	3	2,2	78	1	0,7	1
							176	4	2,9	80	2	1,5	1
							138 ●	6	4,4	92	1	0,7	1
							2	96	70,6	93	1	0,7	1
										137	2	1,5	2
										144	1	0,7	1
										159	3	2,2	3
										217	1	0,7	1
										298	1	0,7	1
										304	2	1,5	[illegible]

1 – RANK
2 – FREQUENCY OF THE SIT
3 – PERCENTAGE OF THE DOCUMENTS
4 – PERCENTAGE OF SIT TOKENS
5 – ACCUMULATIVE PERCENTAGE OF SIT TOKENS
6 – ENTROPY INCREMENT
7 – ACCUMULATIVE ENTROPY
8 – RANK OF RDO
9 – FREQUENCY OF RDO
10 – PERCENTAGE OUT OF THE FREQUENCY OF SIT
11 – RANK OF CONCURENT SIT
12 – FREQUENCY OF THE PAIR OF SIT's
13 – FREQUENCY OF THE PAIR OF SIT's IN PER CENT
14 – NUMBER OF RDO's CONTAINING THE PAIR OF SIT's

SURVEY OF SIT FUNCTIONING

```
RANK    SINGLE INDEXING TERM
        FREKV.  PROC.  PROC.  KUM.PROC.     ENTROPIE      RANK   FREKV.   PROC.   RANK    FREKV.    PROC.     POCET
         JPZ    DOK.    JPZ     JPZ       PRIR.  CELK.    KPZ     KPZ    K JPZ   KOMB   DVOJICE   DVOJICE   KPZ S
                                                                                 JPZ     JPZ      K JPZ    DVOJICI

 1        2      3      4       5          6      7        8       9      10      11      12        13        14
-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-

 ①     625.42
         161    3,4    2,2     2,2       ,114   ,1141     445      1     0,6      2       3        1,9        2
                                                          470      1     0,6      5       5        3,1        3
                                                          479      1     0,6      9      10        6,2        6
                                                           .
                                                           .
                                                           .
-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-

 ②     621.335[illegible]2
         153    3,2    2,1     4,4       ,110   ,2242     443      1     0,7      1       3        2,0        2
                                                          447      1     0,7      5       1        0,7        1
                                                          486      1     0,7      6      13        8,5       11
                                                           .
                                                           .
                                                           .
-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-

 ③     625.282-833.6
         136    2,8    1,9     6,3       ,101   ,3254     526      1     0,7      4      11        8,1        6
                                                          558      1     0,7      5       4        2,9        1
                                                          575      1     0,7      6       4        2,9        2
                                                           .
                                                           .
                                                           .
-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-

1 - RANK                                6 - ENTROPY INCREMENT                         11 - RANK OF CONCURRENT SIT
2 - FREQUENCY OF THE SIT                7 - ACCUMULATIVE ENTROPY                      12 - FREQUENCY OF THE PAIR OF SIT's
3 - PERCENTAGE OF DOCUMENT              8 - RANK OF RDO                               13 - FREQUENCY OF THE PAIR OF SIT's IN PER CENT
4 - PERCENTAGE OF SIT TOKENS            9 - FREQUENCY OF RDO                          14 - NUMBER OF RDO's CONTAINING THE PAIR
5 - ACCUMULATIVE PERCENTAGE OF SIT TOKENS   10 - PERCENTAGE OUT OF THE FREQUENCY OF SIT                OF SIT's
```

SAOF-2 FIG. 4

```
--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--xxx

      PRUMERNY POCET   KPZ   S JEDNIM   JPZ      8,35033                     a

      PRUMERNY POCET KOMB.  JPZ     10,00000                                 b

--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--
```

a - AVERAGE NUMBER OF RDD's CONTAINING A COMMON SIT

b - AVERAGE NUMBER OF CONCURRENT SIT's

SADF-2 FIG. 5

FREQUENCY DICTIONARY OF RETRIEVAL DOCUMENT DESCRIPTIONS (RDD's)

a/ KOMPLEXNI PORADACI ZNAK

RANK	FREKV.	KUMUL. FREKV.	RELAT. FREKV.	R.KUM. FREKV.	PRIRUSTEK ENTROPIE	KUMULAT. ENTROPIE	RANKY JPZ v KPZ				
1	2	3	4	5	6	7	8	9	10	11	12
.											
.											
.											
.											
625.2-597.3:678.5	625.2-592.117										
803	1	3886	0,0	81,2	,0018	4,88595	92	67	0	0	0
621.313.12/.13	621.335.2.025										
804	1	3887	0,0	81,2	,0018	4,88772	93	11	0	0	0
621.313.12/.13	621.436	625.2.011.5	625.282-833.6								
805	1	3888	0,0	81,2	,0018	4,88949	93	50	28	3	⓪
621.313.12/.13	625.2-5	625.28:621.317	621.335.42.025								
806	1	3889	0,0	81,3	,0018	4,89126	93	57	56	23	0
621.313.12/.13	625.39										
807	1	3890	0,0	81,3	,0018	4,89303	93	65	0	0	0
.											
.											
.											
.											

where:
a/ RETRIEVAL DOCUMENT DESCRIPTION
1 - RANK
2 - FREQUENCY
3 - ACCUMULATIVE FREQUENCY
4 - RELATIVE FREQUENCY
5 - RELATIVE ACCUMULATIVE FREQUENCY
6 - ENTROPY INCREMENT
7 - ACCUMULATIVE ENTROPY
8 - 12 - RANKS OF THE SIT's IN THE RDD

SAJF-2 Fig. 6

```
--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--

     PRUMERNY POCET DOKUMENTU OZNACENY JEDNIM   KPZ        2,81033            a

     PRUMERNE PROCENTO DOKUMENTU OZNACENYCH JEDNIM   KPZ        ,058720       b

     PRUMERNY PRIRUSTEK ENTROPIE      ,003805                                 c

--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--
```

a - AVERAGE NUMBER OF DOCUMENTS INDEXED WITH AN EQUIVALENT RDD

b - AVERAGE PERCENTAGE OF DOCUMENTS INDEXED WITH AN EQUIVALENT RDD

c - AVERAGE ENTROPY INCREMENT

SADF-2 FIG. 7

```
--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--

a    POCET VSECH JPZ      7184

b    POCET DOKUMENTU      4786

c    POCET CAST. SETRIDENYCH JPZ      1781

--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--x--xxx
```

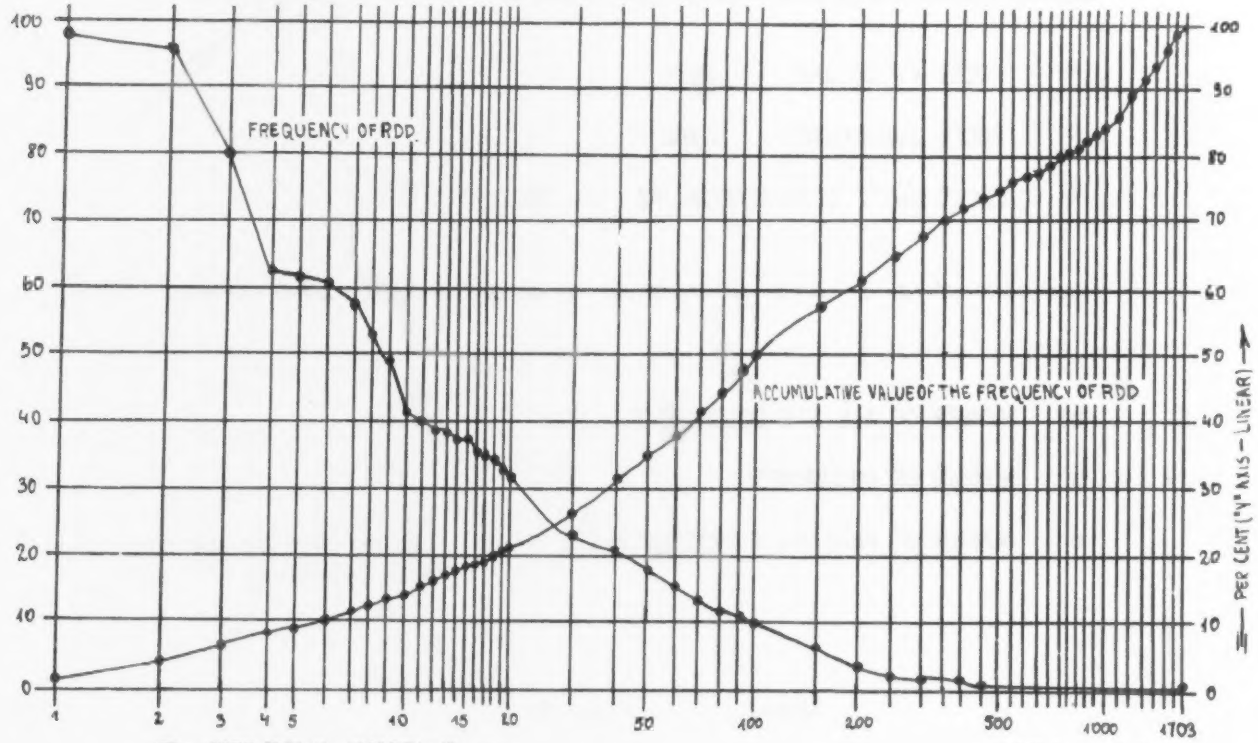
a NUMBER OF ALL SIT OCCURENCES

b NUMBER OF DOCUMENTS

c NUMBER OF PARTIALLY ORDERED SIT's (to be used by the compute operator)

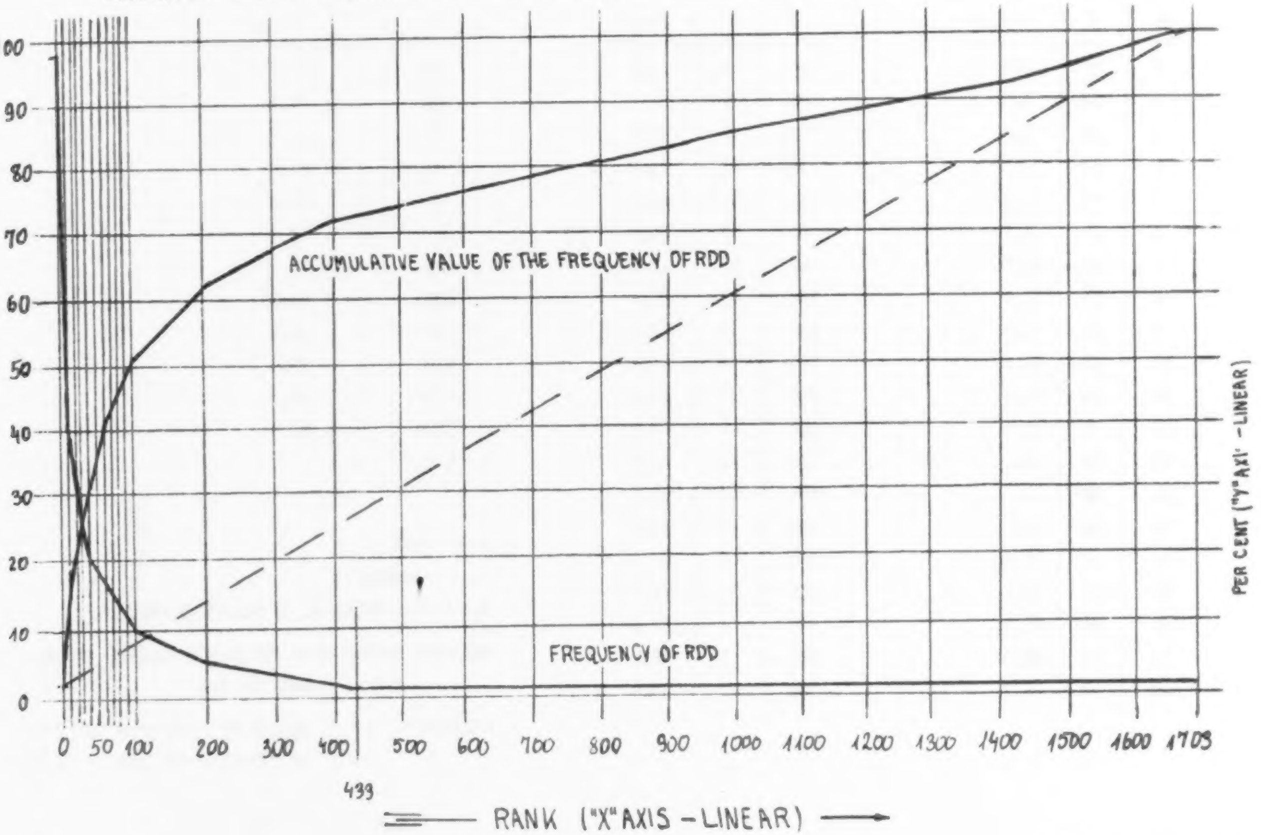
SADF-2 FIG. 8

DIAGRAM OF THE RELATION BETWEEN THE RANK OF A RDD, ITS FREQUENCY AND THE ACCUMULATIVE VALUE OF THE RDD FREQUENCY



SADF-2 FIG. 9

DIAGRAM OF THE RELATION BETWEEN THE RANK OF A RDD, ITS FREQUENCY AND THE ACCUMULATIVE OF THE RDD FREQUENCY



SADF-2 FIG. 10

R	f	R.k.f.
1	98	2,0
2	96	4,1
3	80	5,6
4	63	7,0
5	62	8,3
6	61	9,6
7	57	10,8
8	53	11,9
9	49	12,9
10	42	13,8
11	40	14,6
12	39	15,5
13	39	16,3
14	38	17,1
15	38	17,9
16	37	18,6
17	36	19,4
18	36	20,1
19	33	20,8
20	32	21,5

R	f	R.k.f.
30	24	27,1
40	21	31,7
50	18	35,8
60	16	39,2
70	14	42,2
80	12	44,8
90	11	47,2
100	10	49,4
150	6	57,3
200	4	62,1
250	3	65,4
300	2	67,9
350	2	70,0
400	2	72,1
450	1	73,8
500	1	74,9
550	1	75,9
600	1	77,0
650	1	78,0
700	1	79,0

R	f	R.k.f.
750	1	80,1
800	1	81,1
850	1	82,2
900	1	83,2
950	1	84,3
1000	1	85,3
1200	1	87,4
1200	1	89,5
1300	1	91,6
1400	1	93,7
1500	1	95,8
1600	1	97,8
1703	1	

R - RANK
f - FREQUENCY
R.A.F. - RELATIVE ACCUMULATIVE FREQUENCY

RELATIVE ACCUMULATIVE FREQUENCY REACHES 50 PER CENT
WITH THE RANK OF 103

FREQUENCY f = 2 BEGINS WITH THE RANK OF 274
f = 1 BEGINS WITH THE RANK OF 433

SADF-2 FIG. 11

A	B	C	D					E				
			d_1	d_2	d_3	d_4	d_5	e_1	e_2	e_3	e_4	e_5
1-1	98	1	1					2,0				
2-2	96	1	1					4,1				
3-3	80	1	1					5,6				
4-4	63	1	1					7,0				
5-5	62	1	1					,3				
6-6	61	1	1					9,6				
7-7	57	1	1					10,8				
8-8	53	1	1					11,9				
9-9	49	1	1					12,9				
10-10	42	1	1					13,8				
11-11	40	1	1					14,6				
12-13	39	2	2					16,3				
14-15	38	2	2					17,9				
16-16	37	1	1					18,6				
17-18	36	2	2					20,1				
19-19	33	1	1					20,8				
20-21	32	2	2					22,2				
22-22	30	1	1					22,8				
23-23	29	1	1					23,4				
24-24	27	1	1					24,0				
25-26	26	2	2					25,1				
27-27	25	1	1					25,6				
28-31	24	4	4					27,6				
32-34	23	3	3					29,0				
35-37	22	3	3					30,4				
38-41	21	4	4					32,2				
42-45	20	4	4					33,8				
46-48	19	3	3					35,0				
49-50	18	2	2					35,8				
51-55	17	5	5					37,5				
56-60	16	5	5					39,4				
61-62	15	2	2					39,8				
63-71	14	9	8	1				42,2	42,5			
72-75	13	4	4					43,3	43,6			
76-85	12	10	9	1				45,5	46,1			
86-92	11	7	7					47,1	47,7			
93-104	10	12	10	2				49,2	50,2			
105-113	9	9	9					50,9	51,9			
114-124	8	11	11					52,7	53,7			
125-137	7	13	13					54,6	55,6			
138-156	6	19	16	3				56,7	58,0			
157-175	5	19	14	5				58,2	60,0			
176-207	4	32	17	14		1		59,4	62,6		62,7	
208-273	3	66	32	34				60,1	66,7		66,8	
274-432	2	159	37	110	11	1		61,8	72,8	73,3	73,4	
433-1703	1	1271	95	687	349	77	63	63,8	89,1	97,0	98,7	100
Σ =	46	1703	344	857	360	79	63					

where: A – IDENTIFICATION OF ISO-FREQUENCY GROUP

B – FREQUENCY

C – NUMBER OF RDO's IN THE ISO-FREQUENCY GROUP

D – NUMBER OF RDO's OF THE LENGTH OF :

d_1 – 1 SIT , d_2 – 2 SIT's , d_3 – 3 SIT's , d_4 – 4 SIT's , d_5 – 5 SIT's

E – PERCENTAGE OF THE RDO OCCURENCES (TOKENS – REGARDING THE FREQUENCY OF THE RDO's) OF THE LENGTH OF :

e_1 – 1 SIT , e_2 – 2 SIT's , e_3 – 3 SIT's , e_4 – 4 SIT's , e_5 – 5 SIT's

SADF-2 FIG. 12

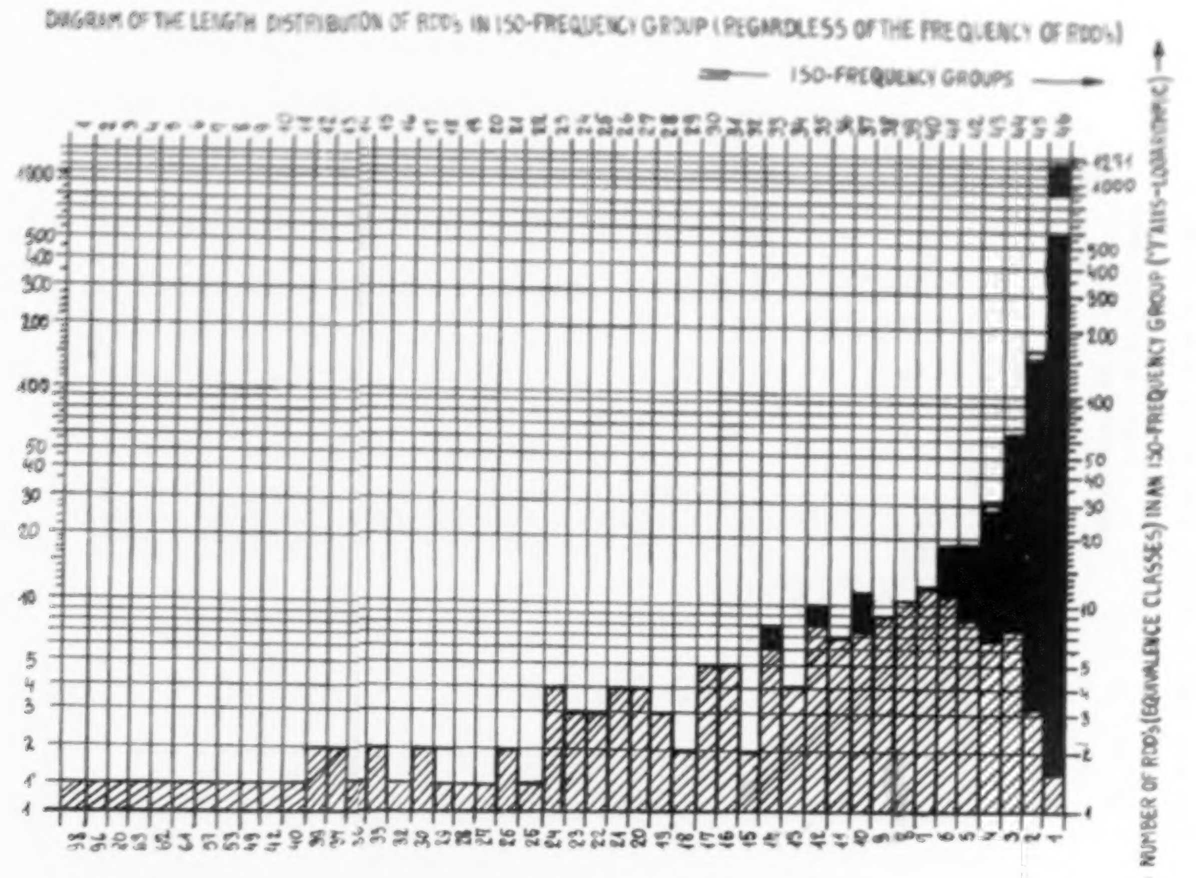


DIAGRAM OF THE LENGTH DISTRIBUTION OF RDD's IN ISO-FREQUENCY GROUP (REGARDLESS OF THE FREQUENCY OF RDD's)
ISO-FREQUENCY GROUPS
NUMBER OF RDD's (EQUIVALENCE CLASSES) IN AN ISO-FREQUENCY GROUP ("Y" AXIS-LOGARITHMIC)
FREQUENCY IN THE PATRICULAR ISO-FREQUENCY GROUP ("X" AXIS-LINEAR)
1
2
3
4
5
10
20
30
40
50
100
200
300
400
500
1000
1291
98 96 70 68 65 64 57 53 49 41 40 36 35 34 33 32 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

SADF-2 FIG. 13

[illegible] [illegible] 14

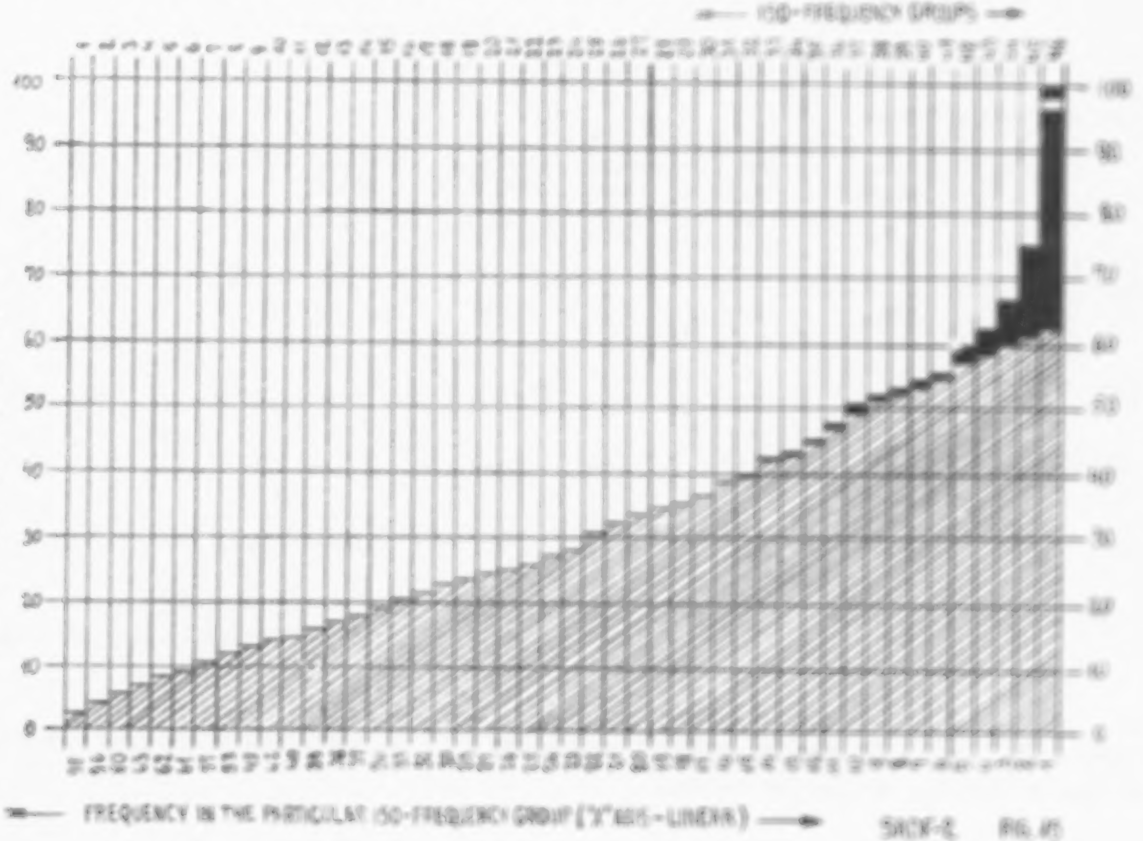
FREQUENCY DICTIONARY OF [illegible] [illegible] DESCRIPTIONS [illegible]

[illegible] [illegible] DESCRIPTION

RANK	FREQU.	ACCUM. FREQU.	RELAT. FREQU.	R.ACUM. FREQU.	[illegible] ENTROPY	ACCUMULAT. ENTROPY	RANKS [illegible]				
1	2	3	4	5	6	7	8	9	10	11	12
[illegible] 30	26	1286	0,5	27,1	,0266	1,24976	45	0	0	0	0
[illegible] 69	[illegible]	1833	0,1	40,4	,0071	1,98[illegible]	33	35	0	0	0
[illegible] 72	[illegible]	2059	0,1	43,0	,0160	2,13349	22	0	0	0	0
[illegible] 76	[illegible]	2097	0,1	43,8	,0730	2,10660	30	28	0	0	0
[illegible] 1156	[illegible]	[illegible] 4237	0,0	[illegible] 88,5	[illegible] ,0076	5,50730	160	141	105	36	44

1 = RANK
2 = FREQUENCY
3 = ACCUMULATIVE FREQUENCY
4 = RELATIVE FREQUENCY
5 = RELATIVE ACCUMULATIVE FREQUENCY
6 = ENTROPY INCREMENT
7 = ACCUMULATIVE ENTROPY
8 - 12 = RANKS OF THE [illegible] IN THE [illegible]

DIAGRAM OF THE LENGTH DISTRIBUTION OF RCCs IN ISO-FREQUENCY GROUPS (REGARDING THE FREQUENCY OF RCCs)



SACK-C FIG. 45

SURVEY OF SINGLE INDEXING TERMS (SIT's) FUNCTIONING

ROD	SINGLE INDEXING TERM FREQU. JPZ	RANG. DOC.	PROC. JPZ	CUM.PROC. JPZ	ENTROPIE PRIR.	CELK.	RANK NPZ	FREKV. NPZ	PROC. K JPZ	RANK KOMB JPZ	FREKV. DVOJICE JPZ	PROC. DVOJICE K JPZ	POCET NPZ S DVOJICI
1	2	3	4	5	6	7	8	9	10	11	12	13	14
⑤	605/445/03 32	0,7	0,4	60,0	,033	3,052	673	1	3,1	6	1	3,1	1
							674	1	3,1	7	3	9,4	2
							675	1	3,1	10	4	12,5	4
							676	1	3,1	16	3	9,4	3
							678	1	3,1	20	4	12,5	3
							1005	1	3,1	25	3	9,4	3
							1045	1	3,1	27	1	3,1	1
							1153	1	3,1	104	1	3,1	1
							1137	1	3,1	134	1	3,1	1
							1206	1	3,1	144	1	3,1	1
							1423	1	3,1	169	1	3,1	1
							1590	1	3,1	179	1	3,1	1
							1667	1	3,1	181	1	3,1	1
							326	2	6,3	250	1	3,1	1
							325	2	6,3	336	1	3,1	1
							62	15	46,9	395	1	3,1	1

1 = ROD
2 = FREQUENCY OF THE SIT
3 = PERCENTAGE OF THE DOCUMENTS
4 = PERCENTAGE OF SIT TOKENS
5 = ACCUMULATIVE PERCENTAGE OF SIT TOKENS

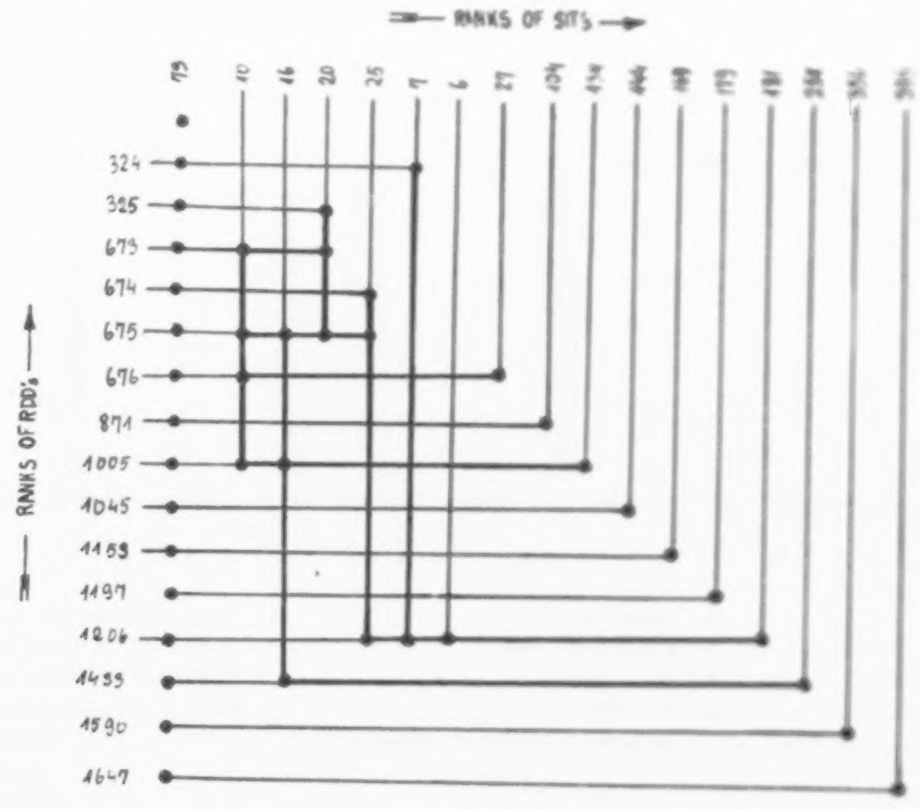
6 = ENTROPY INCREMENT
7 = ACCUMULATIVE ENTROPY
8 = RANK OF NPZ
9 = FREQUENCY OF NPZ
10 = PERCENTAGE OUT OF THE FREQUENCY OF SIT

11 = RANK OF CONCURRENT SIT
12 = FREQUENCY OF THE PAIR OF SIT's
13 = FREQUENCY OF THE PAIR OF SIT's IN PER CENT
14 = NUMBER OF NPZ's CONTAINING THE PAIR OF SIT's

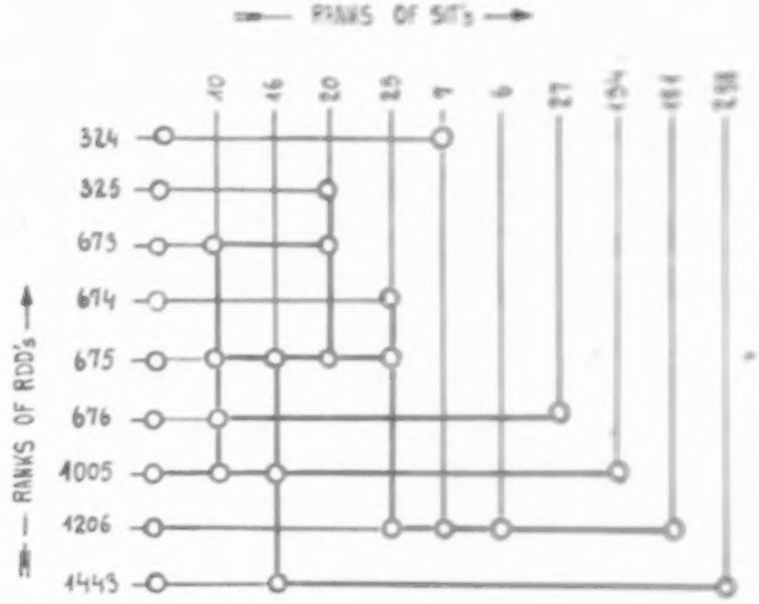
SWAP-2 FIG. 25

DIAGRAM OF THE COMBINATION POWER OF THE SIT OF THE RANK OF 73

SADF-2 FIG.22

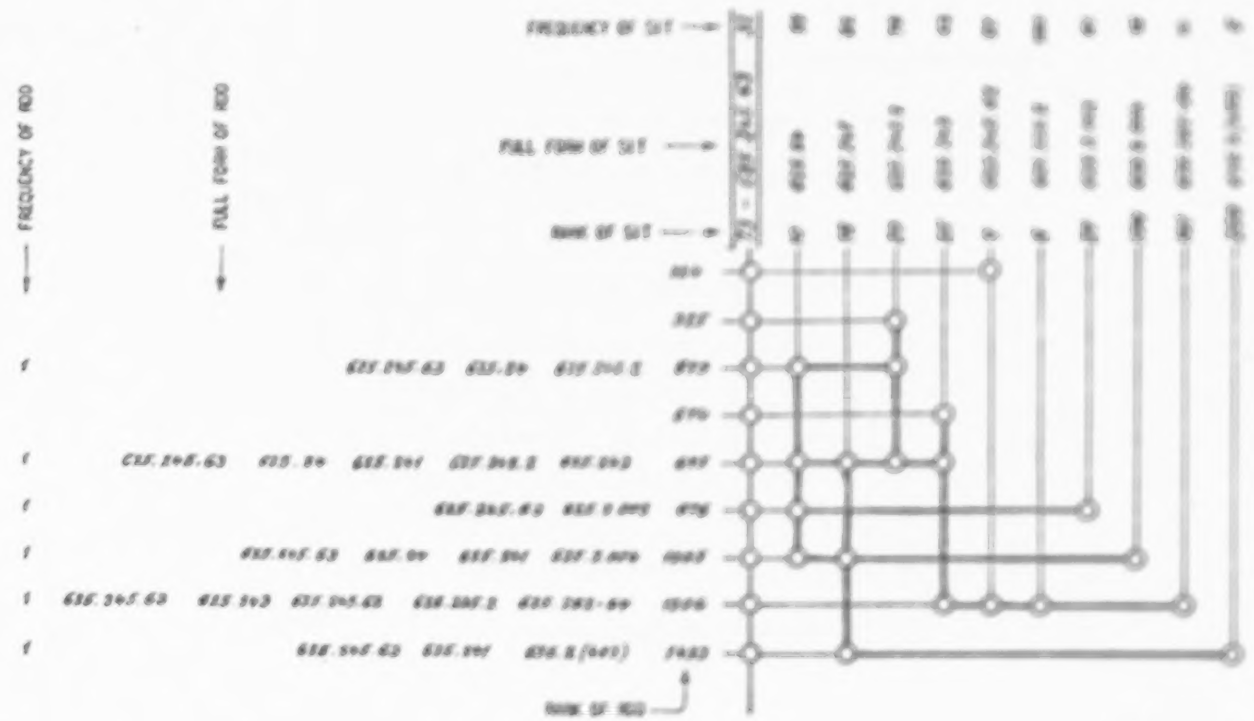


ABBREVIATED DIAGRAM OF THE COMBINATION POWER OF THE SIT OF THE RANK OF 13



SPDF-2 FIG.29

ABBREVIATED DIAGRAM OF THE COMBINATION POWER OF THE SIT OF THE RANK OF 73 (WITH FULL FORM OF SIT's AND ROO's)



[illegible] FIG. [illegible]